BRITISH SOCIETY

FOR THE

STUDY OF ORTHODONTICS

1957

Transactions of the

BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

1957

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Manson House, 26, Portland Place, London, W.1

Published for the Society by

John Wright & Sons Ltd., The Stonebridge Press, Bristol

PRINTED IN GREAT BRITAIN BY
JOHN WRIGHT AND SONS LTD.,
AT THE STONEBRIDGE PRESS,
BRISTOL

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Campbell, J.
Dixon, D. A.
Hopkin, G. B.
Houston, J. G.
Jones, F.
Kemball, C. H.
Logan, W. Russell
Logie, D.
McEwen, J. D.
McGibbon, D. M.
Mears, Miss R.
Miller, Miss M. N.
Munro, D.
Murray, J.
Ritchie, G. S.
Webster, Miss E. M.
White, T. C.

V. Ireland

Adams, C. P.
Bonnar, Miss E. M.
Dallas, H. A.
Dockrell, R. B.
Ellis, D. S.
Fitzgerald, G. M.
Friel, Prof. S.
Keith, J. E.
McKeag, H. T. A.

VI. Isle of Wight

Audsley, C. W.

VII. Colonial and Foreign

Africa

Braude, B.
De Villiers, J. F.
Fainsinger, B. E.
Maister, H. C. L.
Williamson, M. M.

Australia

Adamson, K. T.
Halliday, R. W.
Heath, J. R.
Norton, R. Y.
Reading, J. F.
Seward, J. T.
Spring, D.
Taylor, A. Thornton
Webb, V. P.

Belgium

de Coster, L.
Patcas, H.

Canada

Franklin, G.
Mulligan, W. O.
Oliver, H. T.

Egypt

Bakry, A. L. H.

France

Demoge, P. H.
Gugny, G.
Omeyer, R.

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Ghosh, A. S.

Iraq

Mirza, Y. H.

Malaya

Cheah, C. K.

Malta

Demajo, A.

New Zealand

Cook, C. C.
Gilbert, G. H.
Kean, M. R.
King, Mrs. W.
Lang, E. T.
Suckling, J. G.

Norway

Selmer-Olsen, Prof. R.

Southern Rhodesia

Cross, Miss M.

Sweden

Aslund, Mrs. K.
Granerus, R.
Granse, K. A.
Ljungdahl, L.
Lundstrom, Prof. A.
Palsson, K. F.
Tegner, G.
Volmer Lind, H. C.
Werner, S. H.

Switzerland

Hotz, Prof. R.

U.S.A.

Goldstein, M. C.
Gosman, S. D.
Gottlieb, A. W.
Hellen, Mrs. M.
Parfitt, Prof. G. J.
Sillman, J. H.

THE AETIOLOGY OF MALOCCLUSION—AN ASSESSMENT

Professor **C. F. BALLARD,** F.D.S. D.Orth. R.C.S., M.R.C.S., L.R.C.P.

This paper is a continuation of the main theme of Mr. Hovell's Presidential Address of last year. I make no excuse for this. It is evident that undergraduates rely on text-books for their information and such text-books still over-emphasize the aetiological factors which were taught between twenty and forty years ago, and on which, as Mr. Hovell pointed out, treatment could only be purely empirical. My aim this evening is to attempt to put together briefly the logical conclusions reached by those who have been studying morphology in relation to malocclusions. Most of the evidence for these conclusions has been produced in various papers which, in my opinion, undergraduates should be told to read. I am not, therefore, going to quote references in support of the statements that I make. The main purpose of my paper is to stress the fact that all the available evidence accumulated over the last twenty years leads inevitably to the conclusion that inherited variations are the cause of the majority of malocclusions and that there is no evidence that the individual is as plastic in its environment as many of the text-book aetiological factors require. I would point out that we have now gone a full circle in that originally the main reason for querying accepted theories was the fact that they did not produce satisfactory results when applied to treatment planning. The hypotheses which we now put forward as a result of applying present-day biological principles to clinical experience do produce satisfactory results when applied to treatment planning, and this factor in itself is overwhelming evidence that the hypotheses are correct.

It would appear that, in London anyway, interest in the relationship between orofacial activity and malocclusions began about twenty years ago. In 1935 Miss Van Thal at the Royal Dental Hospital was interested in the relationship between minor defects of articulation and malocclusion; her conclusion in line with present-day thought was that the malocclusion was not the cause. It is highly probable that my interest in orofacial behaviour was stimulated by Miss Van Thal's work.

It is interesting to note that in 1937 Frocschels found that an interdental sigmatism and open bite were caused by lack of tongue control and not that the malocclusion caused the sigmatism and appearance of abnormal tongue behaviour.

In 1945 Gwynne-Evans reported on the work of an Upper Respiratory Clinic. No doubt he had been observing and recording orofacial behaviour in relation to upper respiratory disorders for some years prior to this date.

Rix published his observations in 1946, but again these were most probably the result of many years of clinical observation.

However, the important thing is that over the last twenty years our clinical study has led us to produce a broad classification of postural patterns and patterns of motor activity. It must be realized that variations are infinite, and that as the number classified grows, the picture of distinct types disappears. However, the classification has been of tremendous importance because it has enabled us to record as never before the morphological features and the patterns of motor activity of the infant and growing child in a way that could only be done better, but at prohibitive cost, by cinematography, although cinematography has played an important part in the investigation of posture, activity, and the demonstration of the types. What has not been stressed in the past, but which is no doubt obvious to most of you, is the importance that lateral skull radiographs have played in our analysis of soft-tissue morphology. By means of this technique we have been able to:—

1. Relate the pattern of the dento-alveolar structures to the soft tissues and to the

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skeletal pattern, and to record for future reference.

2. Watch the individual characteristics as the child grows into an adult.

3. Compare variations in families and even recognize racial characteristics.

Furthermore, our lateral skull radiographs and our classifications of morphology have enabled us to record detailed descriptions of individuals before treatment so that we could assess whether there had been any change of morphology as a result of treatment and, what is even more important, so that we could assess the causes of our failures in relation to the morphological patterns.

As a result of studying relapses in a large number of cases, it became obvious that we had to reassess the whole aetiological basis of malocclusion, and, applying biological principles to our clinical observations, the following hypotheses were evolved:—

1. That each individual soon after birth has a characteristic skeletal morphology that does not change significantly throughout the growing period.

2. That no orthodontic treatment will change this skeletal morphology.

3. That soft-tissue morphology, and in particular the patterns of motor activity used for speech, expressive behaviour, and feeding, are equally characteristic of each individual and do not change.

4. Any attempt in orthodontic treatment to put the dento-alveolar structures in a position which is not in balance in these unchanging and unchangeable characteristics leads to relapse.

When we talk about soft-tissue morphology, it is important to realize that we mean not only the size and shape of the soft tissues overlying the bone, but also their posture when they are in their endogenous postural position. The term "endogenous postural position" has previously been defined (Ballard, 1955) and the reason for its use argued. Clinically, there is, as a general rule, no difficulty in determining its position both in the case of the lip and tongue posture and the mandibular posture.

The endogenous postural position is the same as the rest position. Tulley (1953) said that: "Electromyography is not able to show any significant action potential from a resting muscle."

In 1955 Perry said: "Rest position . . . is an area of relative electrical inactivity," and Shpuntoff and Shpuntoff (1956) defined physiological rest position as being when muscles are "silent". They say, however, that the recording of rest position is influenced by posture. The patient should be sitting or preferably standing upright. This seems to me to represent the crux of the matter. The endogenous postural position arises from within the central nervous system and is maintained, I believe it will be shown, when the body as a whole is in abnormal position or in an unusual relationship to gravity. Under these circumstances, however, the muscles will not be electrically silent. I shall be referring to this again later.

The important point, however, is that, as I previously pointed out, the mandible has an endogenous postural position, and it is this position plus the skeletal morphology which determines the vertical dimensions of the maxillo-mandibular space into which the dento-alveolar structures will grow to produce an occlusion. It is of fundamental importance to realize that occlusion does not determine the posture of the mandible, and that the occlusal level is determined as a result of the physiological interaction between:—

1. Reflex control of the endogenous masticatory patterns of activity; and

2. Occlusal stresses controlling growth of the dento-alveolar structures across the maxillo-mandibular space.

As Thompson (1946) has shown, this physiologically established occlusal level is, as a general rule, a position 2–3 mm. closed from the endogenous postural or "rest position"—a normal interocclusal clearance.

It is now evident that not only is there a "normal" occlusal level established, as stated in each individual, but that the "normal" anteroposterior and lateral relationship of the mandible to maxilla in occlusion can also be defined in relation to endogenous postural position. We now recognize a normal path of closure which clinically appears to be a

hinge movement around the condyles. Electromyographically there is symmetrical activity of the closing muscles of mastication to take the mandible through this path of closure. A term which represents the mandible to maxilla relationship in a vertical plane is "centric jaw relationship". The endogenous postural position is a centric jaw relationship, and so should be the final occlusal position. (A position of maximum cuspal interdigitation.) We are now in a position to visualize how an occlusion is established. The dento-alveolar structures grow vertically directed between the linguo-facial balance of soft-tissue morphology and patterns of motor activity, the occlusal level being established as already explained, but the final positioning of the teeth being obtained by cuspal interdigitation. The mandible does not adjust its position to the teeth. The teeth adjust to centric jaw relationship. To avoid trauma to the supporting structures, their position must also be, within very fine limits, the position of balance linguo-facially in soft-tissue morphology and patterns of activity. What occurs when this is not so will be discussed later. It is obvious from what I have just said that I do not agree with Moyers (1956) when he says that: "Centric relation is the position of the mandible as determined by the neuromuscular reflex first learned for controlling mandibular position when the primary teeth were in occlusion." The centric position is not learned; it is endogenous or innate.

The point to be stressed is that the analysis of the relationship of the mandible to maxilla at rest or moving through the normal path of closure to occlusion must be analysed from the endogenous postural position. The significance of this will be appreciated when I refer to habit activities and habit postures.

Sherrington said "all movement begins and ends in posture". When discussing orofacial activity, it must be the endogenous posture from which we begin and end our analysis of motor activity when making a diagnosis. This also applies to the soft tissues of the tongue, lips, and cheeks. With regard to the lips and tongue, again there is a postural position which is a physiological resting or endogenous postural position. This must be assessed with, as a basis, the mandible in its endogenous postural position.

It must be clearly understood what is meant by habit postures and activities, as they are important variations of orofacial behaviour. A habit posture is one which is maintained either reflexly or consciously. It does not permanently replace the endogenous postural position in the central nervous system. Removal of the reflex afferent stimuli or loss of conscious control will immediately result in reversion to the endogenous postural position. Similarly a habit activity is a reflex or conscious control of the endogenous patterns of motor activity and again the more basic patterns are not eliminated from the central nervous system (Ballard, 1955). The postures and activities associated with the incompetent lip posture illustrate these points very well. The open lip posture is the endogenous one, it is not due to lack of tonus in the muscles. To produce an anterior oral seal circumoral contraction is required. The habit posture may be induced reflexly without conscious effort; how this occurs it is not possible to say, it may be that sensory contact of the lips provides the afferent part of the reflex, the original contact being made during swallowing; it may be that there is an innate drive to maintain an anterior oral seal if possible. In some individuals with more severe degrees of incompetent lip morphology, the circumoral contraction can only be maintained by conscious effort. In some cases this may appear to be replaced by reflex maintenance after a time. It is now obvious why the lip exercises with which we used to annoy parents and young children failed so uniformly in their purpose and only succeeded in producing frustrated children and parents.

Similarly, the open lip posture results in a habit pattern of activity during swallowing to produce an anterior oral seal; sometimes it is just an increase in contraction of the circumoral muscles, but quite frequently the tip of the tongue also plays a part by coming between the teeth to contact the lower lip. This is not to be confused with the endogenous tongue-thrusting activity (Ballard, 1955; Fieux, 1953).

There may be some criticism of the use of the term "habit posture" because in the maintenance of a habit posture there is muscle activity. The resulting position, however, is static. I am open to correction if a more physiological term is available.

Habit postures have been discussed previously (Ballard, 1955) and more recently those in association with Class II, division 1 malocclusions (Ballard, 1957 a) and Class II, division 2 (Ballard, 1957 b) have been further described and illustrated. Habit activities of the mandible were discussed in 1954 (Grewcock and Ballard), and I shall have to refer to them when dealing with other questions. It is important to recognize the difference between habit postural positions of the mandible and the occlusal position after displacement due to abnormal occlusion from the endogenous postural position. In the former the mandible moves from the habit postural position through an abnormal path of closure to an occlusion which is a centric jaw relationship. In the latter the mandible is in centric jaw relationship in the postural position and displaces into occlusion. The failure to recognize habit postural positions has resulted in wrong inferences being drawn as to results of treatment and incorrect conclusions being drawn from electromyographical recordings.

Similarly, the variations of orofacial morphology and motor activity and correlated skeletal morphology as the aetiological factors in the production of Class II, division 1, Class II, division 2, and Class III cases have been described already in published papers, or will be described in papers about to be published.

All I wish to emphasize again is that the conclusions reached are the result of twenty years of observation, the most important single factor in these observations perhaps being an ability to assess exactly how the morphology has caused relapse of treated cases. This has removed empiricism from present-day treatment planning.

I now wish to discuss and criticize some of the theoretical aetiological factors of textbooks, and at the same time illustrate the points I have made and fill in some of the gaps left by the papers previously published.

Much confusion has arisen because terms which were adequate fifty years ago are still used but they do not describe accurately any distinct morphological character, behaviour of motor activity, or position. As I proceed, therefore, I shall attempt to define terms which I believe must be brought into our present-day language for clear thought.

Little which appears logical has been written so far about the vertical relationship of the teeth. I quote from White, Gardiner, and Leighton (1954):—

"*Close Bite*—Appears to be overclosure of mandible and failure on part of posterior teeth to reach proper eruptive height. The anterior teeth may then appear to have over-erupted and to present a deep overbite. The opinion is here expressed that many of these cases really present a condition of open bite in the posterior segments of both sides of the dental arches and thus when the posterior teeth are occluded the anterior teeth will naturally present a deep overbite."

Now, if we begin from the endogenous postural position, we immediately have a basis from which it is possible to ascertain where the fault lies, and therefore what treatment, if any, is likely to be successful.

First, the supposition in the above quote is that the excessive incisor overbite, or "close bite" as it is frequently called, is the result of failure on the part of the posterior teeth to prop the jaws open. However, the majority of orthodontic cases showing excessive incisor overbite have an occlusal level which bears the correct relationship to the endogenous postural position. Furthermore, lateral skull radiograph analysis of excessive incisor overbite cases demonstrates quite conclusively that the incisor abnormality is due to either an abnormal axial inclination of the teeth from normal dental base relationship, normal axial inclination, and abnormal dental base relationship, or a combination of the two variations preventing normal incisor occlusal relationship; an occlusion being necessary to control vertical development of the dento-alveolar structures.

This was originally pointed out by the author (1948) and has been reiterated in later papers on Class II, division 1 and Class II, division 2 cases (Ballard, 1957 a, b). The importance of

appreciating the true nature of excessive incisor overbite is, of course, that treatment to open the bite by producing vertical development of the buccal segments will fail for two reasons:—

1. That no change in axial inclination of the incisor teeth or anteroposterior relationship of the dental base is being produced to establish an occlusion.

2. Any vertical growth of buccal segments that does occur temporarily and which encroaches on the interocclusal clearance will relapse as soon as the appliance is removed.

These facts may be obvious to most of you, and yet how often does one see both orthodontists and periodontists treating excessive incisor overbite cases with bite-plates or, what is worse still, some overlay appliance on the posterior teeth which encroaches on a normal interocclusal clearance. It is easy to demonstrate that such an appliance produces in a very short time depression of buccal segments to restore the normal occlusal level for the individual.

Now to deal with abnormalities of the vertical development of the cheek teeth: Any failure in vertical development of the cheek teeth to establish a normal occlusal level is due to either:—

1. A bilateral displacing activity, originally described by J. R. Thompson (1946), and the physiological mechanism suggested by Ballard and Grewcock (1954); or

2. A rare condition of failure of vertical development of the dento-alveolar structures across the maxillo-mandibular space—in other words, a posterior open bite mentioned by Gardiner, Leighton, and White.

The first was dealt with, as already stated, by Grewcock and Ballard (1954), but I wish to reiterate some of the points in order to be able to define some terms. As already stated, the occlusal position of maximum cuspal interdigitation should be on a normal path of closure, in other words, at a centric jaw relationship. At this position no lateral thrust should be put upon the supporting structures of the teeth. If when the mandible closes on a normal path of closure cuspal contacts between two or more teeth are such that abnormal lateral stresses are thrown upon the supporting alveolar structures, then one of two things may happen. Either there may be a reflexly established habit activity which displaces the mandible and so protects the teeth in abnormal position and their supporting structures from trauma. An occlusion of maximum cuspal interdigitation is then established in this displaced position. Alternatively, if for some reason the mandible cannot displace, the teeth which are the subject of the abnormal contact will displace. These teeth are in traumatic occlusion, but the resulting position of maximum cuspal interdigitation is a centric jaw relationship.

The displacing activity is a reflex disturbance of the endogenous patterns of masticatory activity. By putting together the evidence of clinical observation, lateral skull radiograph analysis of the various positions and electromyographical analysis that has been reported in such cases, it is possible to state that when there is a bilateral displacing activity the disturbance of the endogenous patterns of masticatory activity is such that there is control of vertical development of the dento-alveolar structures at an overclosed position. There is an excessive interocclusal clearance. If this is appreciated we are now in a position to define two terms and I suggest discard a third.

To J. R. Thompson (1954) must, I believe, be given the credit for distinguishing between "premature contact" and "initial contact".

Premature contact is that which occurs within the normal interocclusal clearance and does not produce a displacing activity. The teeth are traumatized; they move and permit the mandible to occlude in centric jaw relationship. Initial contact is that which occurs nearer the correct occlusal level, perhaps at it, and from which there is a displacing activity. It is possible for both to occur with some abnormal contacts, a sufficient amount of displacement not being possible to avoid some trauma. The term "centric occlusion" is used for any occlusion which is one of maximum cuspal interdigitation whether it is a centric jaw relationship or a displaced position. Because it is not necessarily a centric

jaw relationship, I suggested it be discarded. (*See also* Bell, 1957.)

Failure of the dento-alveolar structures to develop vertically across a maxillo-mandibular space the dimensions of which are within the normal is a comparatively rare condition. It may be localized to one buccal segment so that there is a true open bite, or it may involve the whole of both arches, in which case there would be an overclosure not necessarily associated with excessive incisor overbite.

Before leaving the subject, I feel that I must criticize three terms in common use, and suggest that they be dropped.

The first is "close bite". It should be obvious from what I have said that this term cannot be used diagnostically because to some it may mean overclosure, and to others it may mean excessive incisor overbite. Then by inference some people seeing an excessive incisor overbite call it a close bite, and think that the cause is failure of vertical development of the cheek teeth. Again the prosthetists, in particular, seem to use the term "close bite" when in fact they mean an overclosure.

The second term is "over-eruption". When a part of an arch does not occlude with the opposing arch at the correct occlusal level, the teeth do not over erupt, but the whole dento-alveolar structure develops vertically. When such a part of the arch is depressed by an appliance, one does not push the teeth back into the alveolus, so reducing the depth of the clinical crown, one depresses the whole dento-alveolar structure.

And finally, the term "exaggerated curve of Spee". The curve of Spee, if there is such a thing, is produced by the combined factors of masticatory patterns of activity and the occlusal contacts of the teeth. When the lower labial segment develops vertically beyond the level of the cheek teeth, it is doing so because the abnormal labial segment relationship did not result in an occlusion. Its final position in contact with either tongue or roof of the mouth, therefore, is not established as the result of masticatory activity. It is not a part therefore of the curve of Spee.

Now to deal with "open bite".

It is now evident, when assessing on a morphological basis, that anterior open bite is due to two main factors. One is soft-tissue behaviour, and the other is skeletal morphology. Factors under the first heading are well known to most of you. It covers tongue thrusting, a postural position of the tongue between the teeth and finger, and thumb-sucking. Unless the tongue-thrusting behaviour is extreme, this type of anterior open bite tends to improve without treatment (Ballard, 1957 a). It certainly improves if the main factor is thumb-sucking and this ceases, although I am personally doubtful as to whether thumb-sucking would produce an extensive open bite unless associated with a tongue-thrusting behaviour. The reason for this view is that in the majority of cases where there is an extreme degree of open bite associated with thumb- or finger-sucking, when the finger- or thumb-sucking ceases the open bite remains, and there is a tongue-thrusting pattern of activity in swallowing.

The anterior open bite due to the skeletal morphology, however, is the one in which there has been as much theorizing on aetiology as there has been in the case of close bite. By observing the skeletal morphology and the pattern, as it were, of the maxillo-mandibular space in relation to the rest position, it is now evident that this type of anterior open bite is associated with a typical pattern of skeletal morphology. It is not due to short ascending rami, the occlusion on the posterior teeth then propping the mandible open or even bending the mandible at the angle as some theories suggest. The typical skeletal morphology is a high gonial angle, a maxilla which is short anteroposteriorly, and there is almost invariably anteroposterior crowding in the maxillary arch in such cases. This combination of factors produces an extreme degree of depth of the maxillo-mandibular space in the labial segment region. It would then appear that the dento-alveolar structures grow vertically, but the inherent growth fails before this deep maxillo-mandibular space has been closed. This hypothesis is supported by the fact that in such cases if one attempts to pull the labial segments together, no further

growth of alveolar bone can be stimulated and the teeth tend to become loose. It is unfortunately possible to have this typical skeletal morphology associated with a tongue-thrusting activity, and in such cases some improvement might remain stable, which appears to contradict my statement. As I have said, cephalometrically it is possible to show that the ascending rami are not short. In such cases one cannot accept the suggestion that the molars prop the mandible open because the occlusal level bears its correct relationship to the endogenous postural position. We must all know from clinical experience how futile it is to attempt to reduce and close the anterior open bite by extracting or grinding cheek teeth. The typical skeletal morphology that I have just described is very like that which some books infer is caused by rickets. It is, of course, a common skeletal morphology associated with the type of Class III occlusion which one sees so frequently in the Scandinavian countries, particularly Sweden. No one would suggest that such a variation in Sweden can be due to malnutrition. Admittedly, this type of skeletal morphology is a combination of variations resulting in the overall pattern being far from the average, but our observation and classification of variations show a smooth distribution to such extremes. For this very reason I, myself, cannot accept the fact that even the extremes which we see fairly frequently are due to environmental factors.

I have just mentioned habits of finger- and thumb-sucking. It would be as well if I reiterated that as the result of relating variations of morphology and orofacial behaviour to malocclusions, one inevitably comes to the conclusion that finger- and thumb-sucking are not important aetiological factors. It occurs in normal occlusions and produces no abnormality whatsoever except perhaps a very slight asymmetrical open bite. It occurs in Class III cases, Class II, division 2 cases, and in Class II, division 1 cases. When it occurs in Class II, division 1 cases the tendency on the part of the observer is to ignore the other morphological features and assume that thumb-sucking is the one and only cause. However, we know now from clinical experience that it is the other features which determine the stable end-result of our treatment, and by deductive reasoning, therefore, one can state quite positively that finger- and thumb-sucking does not produce a Class II, division 1 malocclusion, but only tends to complicate it perhaps by exaggerating the increase of overjet, or if the thumb is sucked unilaterally it may result in a greater forward movement of one buccal segment than the other in the maxillary arch.

Another text-book habit is that of biting the lower lip. I have never seen an abnormality produced by this habit. The cases which are shown in the text-books purporting to be lip-biting habits are quite obviously cases in which there is either a postnormality of mandibular dental base with the lower lip inevitably tucked in underneath the upper incisor teeth. This may be associated with a lip to tip of tongue contact as a habit posture to assist in the production of the anterior oral seal. Or alternatively, the case may be one in which on a Class II dental base relationship there is a typical expressive behaviour of contraction of the lower lip against the lower labial segment and an eversion of the upper lip. This results in a labial segment relationship which is an increased overjet, the lower lip again having to fill this gap.

The theory that mouth-breathing produces malocclusions should have been eliminated from teaching many years ago. In 1929 Brash said: "There is no satisfactory proof that the presence of adenoids, the diminution or absence of nasal breathing, or the constant habit of mouth-breathing can affect the form of the jaws or the position of the teeth in any of the ways that have been suggested. It has still to be proved that there is any significant correlation between the presence of adenoids and the incidence of deformities of the jaws and palate."

In 1932 Warwick James and Somerville Hastings reported that the open lip posture was not necessarily associated with mouth-breathing. The work of Gwynne-Evans and our study of tongue and soft palate posture from lateral skull radiographs and clinical observation have confirmed that mouth-breathing

does not produce a malocclusion. It has also shown why the open lip posture is not necessarily associated with mouth-breathing. In such cases there is a normal posture of tongue, i.e., it is in contact with the soft palate, producing a posterior oral seal. This is seen so frequently in the incompetent lip posture which used to be called the adenoidal facies, that it is now evident that this open lip posture is not in any way related to chronic nasal obstruction. It is not a habit pattern of activity induced by chronic nasal obstruction, it is not lack of tone in the orofacial muscles; it is, in fact, an inherited soft-tissue morphology which has normal tone of the muscles. The other important fact that has arisen is that the children who attend the Upper Respiratory Clinic of Mr. Gwynne-Evans presenting chronic nasal obstruction either due to chronic allergic rhinitis or to chronic obstruction due to adenoidal enlargement are a fair cross-section of all the variations that one sees in the population. In other words, all the abnormalities or variations can have chronic nasal obstruction for years, but they do not change their morphology to the incompetent lip posture or to the contracted maxillary arch with the retruded mandible of the text-books. It is probably unfortunately true to say that a large number of children have their tonsils and adenoids removed simply because they have incompetent lip posture, the supposition being that they are mouth-breathers. The complaint afterwards being, of course, that having had their tonsils and adenoids removed at great expense they still appear to be mouth-breathing.

Bottle-feeding is sometimes given as a cause of a contracted upper arch and a prominent premaxilla. I do not see how bottle-feeding can contract the arch of the neonate because there is no arch. We see all varieties of morphology associated with bottle-fed infants and therefore it cannot be an aetiological factor.

Another statement which one frequently hears is that early loss of deciduous teeth results in underdevelopment of the jaws. The results of our lateral skull radiograph study of cases suffering from early loss of deciduous teeth show us in fact exactly what happens and demonstrate that this supposition is entirely unsound. The skeletal morphology does not change; what happens is that the dental arch in most cases collapses. It collapses because, again, in most mouths the labial segments are supported against the lip to a limited extent by contact with the buccal segments. When this contact is lost the labial segments drop lingually, not an indefinite and progressive amount, but to a degree which is directly proportional to the support the buccal segments give to the labial segments. Furthermore, the posterior teeth tend to drift forward. But again it is obvious that when we relate variations in amount of drift to the morphological features which determine arch length there is a relationship between the amount that the teeth drift forward and the amount of space for successive teeth posteriorly. For instance, take the extremes: if the labial segments are in a position of bimaxillary proclination with a long arch and spaced from the buccal segments, then loss of cheek teeth does not result in any collapse of the labial segments and does not result in forward drift of posterior teeth. On the other hand, when there is a very short maxillary dental base as in some Class III cases with an associated very short arch, early loss of deciduous teeth will result in lingual collapse of the labial segment and in an extreme degree of forward movement of posterior teeth. One can state then from observations that the result of early loss of deciduous teeth is directly proportional to the two factors, the support the buccal segments give to the labial segments and the degree of anteroposterior crowding, or, to put it another way, the degree of disproportion between the anteroposterior arch length and the size of the dentition. Our observations do not support the view that there is a continuous forward growth of the dentition which produces this forward drift of posterior teeth when interstitial contact is lost.

Now finally I must mention function in relation to malocclusions.

I will remind you again that Brash in 1929 said: "There are clearly enormous individual and racial differences in the amount of

exercise which the jaws are given in mastication. Yet over and over again it has been pointed out that the common idea that uncivilized peoples use their jaws a great deal more than the highly civilized in masticating their food, supposed always to be hard and tough, is erroneous. It appears that at the back of all this discussion about the lack of use of the jaws is the erroneous assumption that growth and size of bones must be in some direct ratio to the magnitude of the forces applied to them and the frequency of that application; whereas it is more than probable that there is a very wide range of activity within which growth will proceed in a perfectly normal manner, and that it requires an altogether exceptional degree of lack of use, amounting almost to cessation of use, to affect in any degree the growth of the bones concerned. No amount of exercise, on the other hand, can possibly induce any part of the skeleton to grow beyond the limits to which it is congenitally predetermined . . . but it is highly improbable that he will ever be able, by taking exercise in the form of hard crusts, to add a fraction of that anatomical unit to congenitally narrow jaws."

It would appear that the good work that Brash started is being completely undone by certain inferences made in Part II of the second edition of his lectures. The authors early on in this second part infer that the reason why the humeri of the Irishmen are broader than the humeri of the Italians is probably due to the fact that the former work harder than the latter, although they admit that there may be some racial differences. It is a pity that the stress is made in the direction of function rather than racial differences. I do not believe that any anthropologist would to-day accept the fact that the difference was functional except as a result of natural selection. This is probably the same with our dentitions. It is no longer essential to have an occlusal relationship which permits full use of the endogenous masticatory activity and therefore extreme degrees of variation are surviving only to perpetuate and increase the incidence of these variations in the population.

To sum up, it is more evident than ever that malocclusions are not the result of environmental factors acting postnatally. It is not, therefore, possible by controlling environment to prevent malocclusions. Malocclusions are the result of inherited variations, the details of which we must be able to assess in our diagnosis. If this is so, it means that there is no such thing as preventive orthodontics as an excuse for pædodontists to dabble in orthodontics without adequate knowledge. I think that the fields of the pædodontist and the orthodontist should overlap and that there should not be this intervening subject. Furthermore, I would suggest that, in fact, the knowledge required to make an orthodontic diagnosis is not part of postgraduate orthodontics, but is a subject which must be given early in the clinical teaching of all undergraduates and that the biological background necessary to appreciate the significance of what is taught should be given with the basic science subjects. In other words, no dentist can make a complete analysis of a case unless he can analyse morphology and patterns of motor activity in the way that an orthodontist has to do. This particularly applies, of course, to those who are restoring the dentition, to those who are dealing with abnormalities of function, and who are attempting to improve function or aesthetics surgically. It is a failing of undergraduate teaching that the majority of students only learn what is required before the qualifying examinations. If, as I suggest, the undergraduate training should be changed, then the examination requirements must be altered first. These changes would not only help to remove empiricism from orthodontic practice but also help to remove empiricism from other branches of the practice of dentistry.

REFERENCES

Ballard, C. F. (1948), "Some Bases for Aetiology and Diagnosis in Orthodontics", *Trans. Brit. Soc. Orthodont.*, 37.

— — (1955), "A Consideration of the Physiological Background of Mandibular Posture and Movement", *Dent. Practit.*, **6**, 80; *Trans. Brit. Soc. Orthodont.*, 117.

— — (1957 a), "Morphology in relation to Treatment Planning Symposium—Class II, division 1", *Dent. Practit.*, **7**, 269.

— — (1957 b), "Morphology and Treatment of Class II, division 2 Occlusions", *Trans. europ. orthod. Soc.*, 1956, in the press.

Bell, J. A. (1957), "Centric Occlusion and Related Terminology", *Brit. dent. J.*, **102**, 97.
Brash, J. C. (1929), *The Aetiology of Irregularity and Malocclusion of the Teeth*. Dental Board Lectures. London: The Dental Board of the United Kingdom.
— — (1956), *The Aetiology of Irregularity and Malocclusion of the Teeth*, rev. ed. Dental Board Lectures. London: The Dental Board of the United Kingdom.
Fieux, J. (1953), "Beances incisives et troubles de deglutition", *l'Orthod. franç.*, **24**, 209.
Froeschels, E. (1937), "Sigmatismen und Zahnstellung", *Stomatologie*, **35**, 232.
Grewcock, R. J. G., and Ballard, C. F. (1954), "The Clinical Aspects and Physiological Meehanism of Abnormal Paths of Closure", *Dent. Practit.*, **6**, 259, 291.
Gwynne-Evans, E. (1945), "Discussion on an Upper Respiratory Clinic for Children", *Proc. R. Soc. Med.*, **38**, 535.
James, W. Warwick, and Hastings, Somerville (1932), "Discussion on Mouth Breathing and Nasal Obstruction" (Odont. Sect.), *R. Soc. Med. Trans.*, **25**, 1345; *Dent. Rec.*, **52**, 306.
Moyers, R. C. (1956), "Some Physiologie Considerations of Centrie and Other Jaw Relations", *J. prosth. Dent.*, **6**, 183.
Perry, H. T. (1955), "Functional Electromyography of the Temporal and Masseter Muscles in Class II, division 1 Malocclusion and Excellent Occlusion", *Angle Orthodont.*, **25**, 1.
Rix, R. E. (1946), "Deglutition and the Teeth", *Dent. Rec.*, **66**, 103.
Shpuntoff, H., and Shpuntoff, W. (1956), "A Study of Physiologic Rest Position and Centrie Position by Electromyography", *J. prosth. Dent.*, **6**, 621.
Thompson, J. R. (1946), "The Rest Position of the Mandible and its Significance to Dental Science", *J. Amer. dent. Ass.*, **33**, 151.
— — (1954), "Concepts regarding Function of the Stomatognathic System", *Ibid.*, **48**, 627.
Tulley, W. J. (1953), "Methods of Recording Patterns of Behaviour of the Orofacial Muscles using the Electromyograph", *Dent. Rec.*, **73**, 741; *Trans. Brit. Soc. Orthodont.*, 88.
Van Thal, J. H. (1935), "The Relationship between Faults of Dentition and Defects of Speech", *Proc. Int. Congr. phon. Sci.*
White, T. C., Gardiner, J. H., and Leighton, B. C. (1954), *Orthodontics for Dental Students*, 1st ed. London: Staples Press.

DISCUSSION

Mr. W. J. Tulley thanked the President for his address. This was a welcome review of a number of the developments of modern orthodontic thought which had become possible with the better understanding of facial growth and muscle physiology. It gave an opportunity to discuss some of the controversial issues "on the floor of the house". It was an opportunity for which many members had been waiting.

Mr. Tulley was in agreement with much of what the President had said, particularly on the removal from text-books of many misleading statements. He eould not agree fully on the question of undergraduate education. All that one could do in the undergraduate curriculum was to teach a few basic praetical principles.

The term "close bite" was one whieh was most confusing to the undergraduates. As the President had pointed out, it was rare to find a true close bite with definite lack of vertical development of the dento-alveolar structures. The case of the cleft palate, however, was one in which there was a true lack of vertical development of the dento-alveolar structures across the maxillo-mandibular space. In expressing agreement with the President's statement concerning Brash's original Dental Board Lectures, Mr. Tulley said there was a clarity in that original work which was sadly lacking to-day.

He took issue with the President on the question of habit reflexes and habit postures. He knew that academically speaking these acquired habits were not true changes of behaviour, but was this really significant from a clinical point of view? If one obtained a forward bite, and a position of the lips which were stable, did this really matter so long as nobody fooled himself that he had basically changed the pattern or changed the behaviour?

On the problem of terminology and definitions, he found "endogenous resting posture" rather a mouthful. The President used this expression becausc he wished to overemphasize the fact that the resting posture was endogenous, but people should restrict themselves to using the term "rest position" or "resting posture" without trying to put into the term too much of its definition. Much as he disliked nomenclature committees, Mr. Tulley thought that there should be a simple, common terminology, which needed to be thrashed out a good deal more than it had been.

He fought shy also of another of the President's terms —"incompetent lip morphology"—not because of disagreement but because it was really defining a lack of innate lip seal. It was necessary to distinguish between a shape of the lips which did not allow them to meet —short lips—and lips which anatomically were perfectly capable of effecting a seal but had this posture which made them incompetent. "Incompetent lip morphology" and "incompetent lip posture", he thought, were two different things. They might be found together, or they might not. One should stick to the term "lip seal" or "lack of lip seal" but understand what was meant by them.

Mr. Tulley hoped that members could really argue out some of the more controversial points of the Presidential Address. There were many present who would disagree with the President on the question of sucking habits, close bite, and a number of other points. Thankfully, he was himself in agreement on most of the points which had been made, even if he did not quite agree with the terminology.

Mr. J. H. Gardiner congratulated the President on the new thought he had introduced and on the opportunity which was provided of discussing the Presidential Address. He was particularly interested in the remarks concerning orthodontic text-books, and he would like to challenge the statement which had been made about the part which premature loss of the deciduous teeth, especially the deciduous molars, played in the causation of malocclusion.

In his own experience, the premature loss of deciduous molars had caused space loss in 60 per cent of cases. In some of that 60 per cent it had actually caused a malocclusion, but largely it had contributed to a malocclusion. He would be interested to know what others had experienced.

He asked what actual form of treatment the President nstituted to produce a new incisor relation—for instance, in an angle Class II, division 2 malocclusion.

Mr. B. C. Leighton agreed that the challenge thrown out by the President to authors of text-books should not go unanswered. The authors of one text-book at least would take note of all that had been said.

He thought the statement that the deep incisor overbite appeared to be due to an actual eruption in the molar and premolar region was based on the observation in a few cases that where there was a deep overbite, the angle formed by the mandibular plane and the maxillary plane was small, whereas in cases where there was an anterior open bite or a small incisor overbite the angle appeared to be large. The President had produced evidence not formerly available, and it was recognized that his evidence should receive consideration.

Mr. Leighton had a feeling that students would not welcome some of the President's suggestions about terminology, which was extremely difficult to learn and to understand. What was needed was greater simplicity and a greater use of words which were in normal, general lay use, so that a student could understand at once what was intended.

The President's observations on mouth-breathing referred, presumably, to cases where there was a combination of nasal and mouth-breathing. His own experience was that cases in which there was a complete nasal obstruction showed certain similarities. There was very often an apparently excessive depth between the nose and the chin; there was a large mandibular angle. Such cases seemed to be quite typical. Whether the nasal obstruction was the cause of the picture or the result of it, or was merely associated with it, he was not himself prepared to say.

The Address was an excellent one and deserving of much closer study.

Mr. J. C. Ritchie, who observed that all the illustrations were of older children or even adolescents, wondered whether the President had considered looking for many of the abnormalities in very small children. Over the past twenty years he had himself learned more about orthodontics from the very young children than from the adult patient.

Many orthodontists must change their ideas quite a lot and accept the idea of treating very small children. At the present time, about a quarter of his own patients were children who had nothing but temporary teeth. Many of the abnormalities were showing in those tender years, and it was much easier to treat these conditions at an early age.

One could not look forward as to what might have appeared if the condition had not been treated. On the other hand, in the cases illustrated by the President there was no looking back.

Mr. J. H. Hovell said it was a very considerable time since the President first put him on the right lines by pointing out quite a lot of things he had not previously realized. Since then, their two paths had diverged somewhat. After listening to the Address, it was surprising to realize how, although they had diverged, the effect of the President's original stimulus upon his way of thinking had led him to reach virtually the same conclusions himself. In fact, he had never listened to a paper with which he more fully agreed than the one they had heard to-night.

He heartily endorsed all that the President had said about text-books, which, for his own part he thought, served only to muddle the student and give him completely wrong ideas. Terms such as "close bite", which were obsolete many years ago, should be discarded from all orthodontic text-books. Any thinking person should now discard all these old shibboleths which had persisted ever since the days of Collier.

The President's exposition of the centric relationship of the jaw as opposed to the centric occlusion of the teeth was excellent. Mr. Hovell added that he rather liked Moyers's term "eccentric occlusion" as applying to all those cases in which the path of closure had deviated from the normal and resulted in a jaw relationship which was not centric in the dental occlusal position.

Furthermore, he wished to stress what the President had said about orthodontists referring to general dental surgery. It was quite essential that the dental undergraduate student should be taught to think physiologically as to the correct development of occlusion if he was to carry out his general dental surgery on satisfactory lines. The full-denture prosthetist would come to grief if he did not obey and understand the physiological considerations which governed the development of occlusion.

In a paper to the Royal Society of Medicine, Beyron has shown how faulty restorative treatment could cause terrific disruptions of occlusion.

Miss E. M. Myers said it was appropriate not only to thank the President for his paper but to express appreciation of his sequel to Mr. Hovell's Presidential Address of the previous year.

She was a little confused by the President's chronology. He had mentioned a magical number of twenty years, but Professor Brash's Dental Board Lecture of 1929 was much longer ago than that. The President's own paper, which always remained firmly in her mind, was given in 1948. In her view, these two dates had always been landmarks in orthodontics, and apart, perhaps, from Sir Norman Bennett, the President should be acknowledged as the only person who had really got to grips with the problem of aetiology, in this country at any rate.

Mr. D. H. Oliver said that a previous speaker had stressed the question of deciduous teeth, which had also been referred to as temporary teeth. He himself wanted to stress the necessity to call them "foundation teeth". This had been spoken of from time to time at various meetings recently. It would not only help to educate the public as to the vital functions of deciduous teeth but would get people away from the name "deciduous", which was misleading to people. It would also help students to appreciate the prime importance of the first teeth. There was no one better fitted than orthodontists to educate the public in this way.

Mr. J. R. E. Mills added his thanks to the President for a very stimulating paper. One of the most interesting problems in orthodontics, to himself at any rate, was the question of deep overbite. An earlier speaker had already asked how the President treated his cases of deep overbite which was caused by increased vertical movement of the incisors. The President was opposed to the use of the bite-plate in these cases, but if the deep overbite were associated with a large overjet, the latter could only be reduced if the former could be controlled.

Mr. Mills wondered if there was not a tendency to regard the individual as static, whereas, in fact, the young individual was growing, quite actively. If, however, the condition was retained for a long period, the individual would grow, and a vertical dimension which was "over-opened" in the small face might be acceptable in the larger face after growth had taken place.

He agreed with the President about the need for more emphasis in the teaching of orthodontics in undergraduate teaehing hospitals. If orthodontics was to be the first clinical subject taught to students, it would be necessary to point out that that which the orthodontists called "endogenous resting posture" was known to all other departments of the hospital as "rest position".

The President, replying to the discussion, said he did not think there would be so much difficulty with undergraduates if they had proper basic science training. They would have no difficulty with some of the terms and no difficulty in understanding what was meant if they were taught present-day biological principles.

He agreed that the habit posture of the mandible did not matter as long as one realized exactly what it was. The point was, however, that many people had produced cases in which there was, quite obviously, a forward posturing of the mandible as habit after treatment and they then said: "Look, we have made the mandible grow." The fundamental fact was that those people had not made the mandible grow: they had stimulated the forward posture.

In all the cases he had seen, the forward posture went back to the normal position for masticatory purposes, and this tended to spoil the appearance.

The President did not want to continue the argument about "endogenous posture position", "rest position", and so on. He had already said that one of the reasons why he did not like the term "rest position" was that it inferred that the muscles were necessarily at this position of electrical silence, whereas the posture itself was the important thing. It arose within the central nervous system and if it required some activity of muscle to maintain it, that activity was produced quite reflexly.

With regard to incompetent lip morphology and lip seal, again there was a fundamental difference between lip seal and lack of lip seal. The fundamental difference was the contraction of the orbicularis to maintain lip seal as against the case where there was lack of lip seal. There was a group of Class II, division 1 cases in which the lips did not meet because the upper incisors were between the teeth but there was no contraction of the orbicularis and mentalis muscles. It was known that as long as this contraction was not present, one could procline the lower labial segment against the lip activity. If, however, there was any degree of contraction to maintain a lip seal, one could not procline the lower labial segment, in spite of the fact that the differentiation referred to by Mr. Tulley would lead one to diagnose lip seal.

In expressing his agreement with Mr. Gardiner concerning the premature loss of deciduous molars, the President pointed out that he had not said that there was loss of space. There had not been time to expand on this aspect. The degree of loss of space with premature loss of foundation teeth was, he thought, directly proportional to the degree of discrepancy between the size of the dentition and the length of the arch, thc length of the arch being determined by the morphology of the individual. In other words, potential crowding was present anyway and the early loss of deciduous teeth only shifted it from one side of the arch to another.

Mr. Gardiner and another member had raised the question of the treatment of Class II, division 2 cases. This question probably would not have been asked had those who raised it been using lateral radiographs to assess thc changes of inclination of the teeth during treatment. It was now known exactly what happened in Class II, division 2 cases. The important feature, however, was that any improvement in the incisor overbite of a Class II, division 2 case, as in a Class II, division 1 case, was due to a change of axial inclination of the teeth to restore a more normal relationship of the labial segments.

There was a paper in the press in which this had been carefully analysed. The degree of improvement which was possible in Class II, division 2 cases and which remained stable was directly proportional, the President thought, to the degree of the original abnormality. In other words, the morphology of the individual determined the improvement that was possible.

He had always expected that somebody would raise, as Mr. Leighton had done, the question of deep overbite and the angle between the maxilla and the mandible. Those who had looked at lateral radiographs in relation to incisor overbite during the last fifteen years were convinced that the overbite was directly related to the abnormal occlusal relationship of the teeth. There was, however, a correlation between a low angle between the maxilla and the mandible and the Class II, division 2 type of incisor overbite, but this did not mean that the low angle produced the excessive incisor overbite. It was an association only. One was not the cause of the other.

In reply to the criticism that students would not understand his terminology, he was prepared to agree that some of it was a little bit ambiguous and perhaps difficult; but the question of terminology would not be so difficult to the undergraduates if their biological background was adequate.

The complete nasal obstruction case, which Mr. Leighton had mentioned, concerned an association of characters. As a general rule, the long-faced individual with the high gonial angle, with the deep intermaxillary space anteriorly and with the high palate, had a narrow airway. A narrow nasal airway was, of course, more easily obstructed by engorgement of the nasal mucosa. An individual with this type of skeletal morphology tended to have a more easily and completely obstructed narrow nasal airway; but the one was not the cause of the other. There were, of course, quite a number of cases on record in which there had been complete nasal atresia with normal development of maxilla and mandible.

In reply to Mr. Ritchie's remarks on the treatment of young children, the President said that at the Royal Dental Hospital treatment was begun on children at $3\frac{1}{2}$ or 4 years of age, but the conclusion was reached that it was a complete waste of time. The abnormality could not be completely treated at that stage. During the shedding of the deciduous dentition the treatment tended to relapsc completely and treatment had to be started again in the adult dentition. One of the reasons, of course, was that there was not sufficient bone growth to move upper cheek teeth distally. Therefore, as a high percentage of the abnormalities in this country had anteroposterior overcrowding of the maxillary dentition, it was not possible to treat until units could be removed or until there was some growth at the back of the maxillary arch.

The President said he was convinced that treatment in the young child was a complete waste of time, and he had proved it to his own satisfaction.

Replying to Miss Myers, he pointed out that his whole orthodontic outlook started with Brash's Dental Board lectures. He still regarded them as one of the most important set of lectures ever published. The opening remarks of the Address, however, referred to soft-tissue morphology. One of the things that Brash lacked was an appreciation of the part that soft-tissue morphology played in placing the dento-alveolar structures. Had he understood then what was known to-day, the profession would be much farther ahead. The chronology of the Address, therefore, really started with an early study of soft-tissue behaviour.

The President said he still did not agree with Mr. Mills that the bite-plate would change the relationship of basal bone of mandible to maxilla. In other words, he agreed that in some of the cases what probably happened was that when a bite-plate was put in, although the lower labial segment was not depressed, normal vertical growth was taking place. The vertical growth, however, was only changed within the normal pattern of the individual. The maxillary-mandibular plane angle did not change. He would not agree if it was thought that the depth of the maxillary-mandibular space could, as it were, be increased beyond the normal for the individual.

Another aspect about treating Class II, division 2 cases was that, from the lateral radiograph analysis, an ordinary bite-plate would not permanently reduce the incisor overbite. This had been stressed both in the paper to-night and in a number of other papers. Therefore, the mere fitting of a bite-plate would not do that. The relationship of upper to lower labial segments must be changed.

The thanks of the meeting to the President, for his Address and for his reply to the discussion, were unanimously accorded by acclamation.

REPORT ON THE EDGEWISE APPLIANCE

By **J. R. HALDEN**, L.D.S. R.C.S., B.D.S., D.Orth. R.C.S.

My interest in the edgewise appliance dates from the time that our President returned from the United States, and read a paper to this Society in which were the following words: "The Tweed philosophy is, very briefly, the extraction of four first premolars in a high percentage of cases, and the use of the edgewise arch. The space of the lower first premolars is partly closed by forward movement of buccal segments, and the anchorage so obtained is used to bring back labial segments and move distally, if necessary, the upper buccal segments. In capable and intelligent hands I believe that this method produces a higher percentage of successfully treated cases not requiring prolonged retention than any other philosophy at present in vogue in North America." Those words were particularly significant then, for they were spoken at a time, difficult to remember now, when the twin arch was still the latest thing in this country and considered by most as being the very last word.

It had been realized at that time (Ballard, 1947) that the orofacial muscle pattern common to a high proportion of cases in this country does not permit the lower labial segment to be proclined and to remain stable. It followed that most cases with crowding in the lower arch would have to be treated by extraction, probably of first premolars, and it followed again that an appliance had to be found that could close the spaces from in front or from behind without allowing tilting and rotation of the teeth on either side of the extraction space. The extract from the paper that has been quoted seemed to point out the way to do this. The remainder of this paper will be an attempt to show how much progress has been made in the search for an adequate technique, and how that search was conducted.

Since dollar restrictions made purchase of the manufactured edgewise brackets, tubes, eyelets, and pliers impossible, it was decided to make the parts by hand and to obtain the pliers by modifying existing patterns. Fortunately it transpired that rectangular wire was being made here for export to Australia, so the most difficult problem of all did not have to be solved. Brackets were made from 1·5 mm. wire by cutting the bracket slots with a circular saw and the wings with a disk. The first case on which they were tried out was one for whom four sixes had been extracted, since this type had always presented problems of space elosure and correction of tilts and rotations that were beyond the powers of simple appliances.

After making many hundreds of brackets by hand, it was decided to have them machine made out of stainless steel, and treatment then became much easier, if only because the bracket slot was henceforth at a more constant angle to the tooth surface. The results were encouraging, and many cases were successfully treated; but the method was very time-consuming. Text-books can teach one a basic technique, but not speed and dexterity. It was felt that a visit to the United States would be most valuable at this stage.

Accordingly, it was arranged that I should visit Tufts University School of Dental Medicine in Boston, and Northwestern University, and the University of Illinois School of Dentistry in Chicago. In addition, through the generosity of the Tweed Foundation for Orthodontic Research, it was arranged that I should call on its secretary, Dr. Herzberg, in Chicago, and then carry on to Tucson, Arizona, with a scholarship to take the 1954 Tweed teaching course there. The Eastman Dental Hospital generously made a contribution towards my expenses.

Upon my arrival in Boston, in March, 1954, Dr. Margolis and his staff made me very welcome, and I sat in on several seminars. Tufts is largely an edgewise school, though extra-oral traction and bite-plates are used quite a lot. Theirs is a simplified version of

Given at the meeting held on February 11, 1957.

thc Tweed philosophy, without the more complex anchorage preparation procedures. In common with many men on the East eoast, they oftcn like to have molar-width brackets on all bands except thc anchor molars, so that staples are not necessary. I was to meet several of their instruetors later as fellow-seminarists on the Tweed eourse.

From Boston I journeyed to Chieago and visitcd Dr. Thompson. He made me very welcome both in his office and at Northwestern University and hc arranged for me to visit Dr. Brodie and Dr. Herzberg. All three men invited me to call in at their offiees whenever I liked. Thompson uses the edgewise applianee in his own office and I notcd espeeially that hc uses bueeal tubes both on the lower first and second molars of the same casc. He feels that he obtains better anchorage that way. His practice is largely concerned with problems of bite analysis.

I watched Brodie at work in his office on several occasions. He uses preeious metal bands *and* arehwires, and treatment procedures that are perhaps more akin to Angle's than are most men's. He is loath to extract, and likes in suitable eases to expand the dental arches by bodily movement of the teeth with the edgewise arch, so as to make room for the alinement of the teeth, and then to leave out the arches and see if the case "pops". If it doesn't, he removes the bands; if it does, he takes out four premolars and the case is already half finished. I admit that I was sceptical of that last statement at the time, but since having had to carry out a similar proeedure for a case referred to me from the States, by a man holding similar views to Brodie's, I have been surpriscd how quickly spaee closure can be accomplished when all the alinements, rotations, etc., have been attended to. Both Dr. Brodie and Dr. Renfroe, the instruetor in technique at the School of Dentistry, treat their Class II eases by mass distal movemcnt of the upper arch, using precious metal arehwircs. Thc second ordcr or tip-back bends are so slight that they are barely visible, and they are not increased until it is apparent that distal movemcnt has stopped. Class II elasties are used to a fully strapped-up lower arch.

With regard to expansion, Brodie felt that little is known about muscle growth, but that it *is* known that museles will adapt themselves to an increase in length and change of function. Their development may lag behind that of thc skeleton. Expansion may relapse if done too quickly for the museles to adapt themselves, so it must be done gradually and with light foree. He mentioned a paper by Walter (1951) on "Changes in the Form and Dimensions of Dental Arehes Resulting from Orthodontie Treatment" for evidence that expansion quite often holds. He did say that he was unable to be sure beforehand when expansion would hold and when it wouldn't, but that one acquired an intuitive assessment of a case with experienee. In this respect several men told me that it was easier to admire Brodie's own results than to equal them. I saw the models of several cases where expansion had held years out of retention. Dr. Downs, who has a tremendous reputation as an orthodontist, is much keener on extractions and is more inclined to the Tweed way of thinking. Unfortunately I saw less of him than I should have liked, because he only attended the school for two of the days out of my stay in Chicago. He was quite sure that the A point could be shifted posteriorly by eorrect edgcwise arch technique.

Dr. Herzberg is the Secretary of the Tweed Foundation. He is a part-time teacher at Northwestern University. You will be familiar with his numerous papers on the use of the Tweed philosophy in praetiee and its effect on the profile. He uses stainless steel bands, and hc was the only orthodontist I saw in action employing a technician. They mostly do their models and retainers themselves, and I often saw the method deseribed by Tulley (1956) being used, but for routine rather than for temporary use. Herzberg does carry out the anchorage preparation procedures and does reduce bimaxillary proclinations with great benefit to the profile at the end of active treatment. He assured me he had no trouble with spaees reopening with these cases, even though he seldom places a retainer. He will be visiting us later on this year, and I hope he will bring some eases to show us.

From Chicago I left for Tucson, near the Mexican border, on the edge of the Arizona desert, to spend a week with Dr. Tweed prior to the course. This week was spent in strapping up my typodont, seeing patients under treatment, and in helping him with preparations. Everything possible to make my stay worth while was done. At the end of the week the six instructors arrived, soon followed by the thirty-six men and one woman taking the course, and on the appointed day the work began. We started at 8.30 each morning and finished, theoretically, at 5.30. In practice we never stopped before 11.15 at night, at which time we used to go round to our nearby motel and talk till midnight. There were many lectures and film shows, but, after a briefing in the morning, most of the time was spent working on our typodonts. There were long zinc troughs heated by gas for us to "dunk" our typodonts in, benches for us to work at, tracing tables, a lecture hall, and benches where one could solder. We were told that we were the largest class to date and the first one to finish within the scheduled time. Nowadays the classes are even bigger, for the April course of this year has fifty-six members, the total capacity for attendance, and a waiting list of over forty may have to be absorbed by an October course as well. Incidentally, Dr. Reidell was on this course. I compared our approach to diagnosis with his, and found that he is fully as interested as we are in physiology in relation to the aetiology of malocclusion, though he does not go quite as far as we do. I mention this because not all Americans are purely mechanical in their outlook. It would be truer to say, I believe, that they are more loath to commit themselves to print about concepts that, as we have found, are almost incapable of objective proof. I think we have blazed the trail in relating variations in soft-tissue morphology to specific malocclusions, but let us not fool ourselves that we are alone in the field.

In view of this American interest in Tweed and his work, I thought you might like to have some details of how he uses the edgewise mechanism. He is a brilliant, practical man, and whether he is right or wrong in his views, his technique is outstanding and can solve many of our problems for us. Moreover, please remember that he is interested above all in facial æsthetics; he is not concerned whether certain types of orofacial musculature will permit a stable proclination of the lower labial segment because he would dislike the effect upon the profile anyway. He will only compromise in extreme cases, ones that are beyond the scope of the elaborate technique he has evolved to put his concepts into practice.

Any discussion of Tweed's treatment procedures will involve descriptions of anchorage preparation as he understands it, so it will be as well if I try to clarify what he means by that term. I will quote: "By anchorage preparation I mean the placing of the mandibular incisors up over basal bone, or maintaining them on the basal bone, and arranging the axial inclination of the teeth in the buccal segments, from cuspid to second molar when possible, in such a manner as to create slightly distal-axial inclinations of the anchor molars, whether first or second molars." In other words he likes to tip back the teeth in the buccal segments until they are leaning away from the direction of pull and offering the same resistance to displacement as a tent peg does to its guy-rope. If you agree that it is better to finish your case with the teeth in the buccal segments upright or leaning slightly backwards in order to minimize the danger of the extraction space's reopening, then you will be wise to consider tipping them back *before* you start to pull on them because it is nearly impossible to tip them back *while* you are pulling them forward. If you tip them back first, you can, by slight increases in the tip-back effect of your archwire at each visit, ensure that the teeth remain tipped back, and hence that they have to be shifted bodily forwards by the displacing force if they have to give way at all. Tweed also likes to tip the lower incisors five degrees posteriorly beyond the angulation to the Frankfort plane that he wishes eventually to attain, because he likes to allow for the inevitable forward displacement of the whole lower arch under

Class II elastics that occurs no matter how perfect one's anchorage preparation has been. You have to make up your own mind about all this because opinion is not unanimous. No less an authority than Brodie maintains that the strongest anchorage is provided by teeth that have had only a minimum of "limbering up" to permit the placing of a heavy archwire, and hence a minimum of cellular reorganization around their roots.

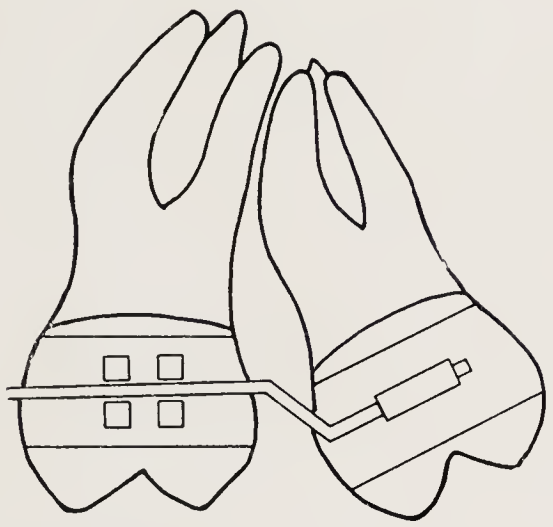


Fig. 1.—Tip-back bend (shown exaggerated for clarity) tipping an upper anchor molar distally, without traction.

To bring about this distal tipping of teeth, whether it be in the lower arch to prepare anchorage, or in the upper to retract all the teeth and correct a Class II condition, Tweed uses extensively a method of moving teeth that is peculiar to the edgewise appliance. This involves the distal tipping of whole arches or segments of an arch *en masse* by a combination of tip-back bends and elastic traction. A tip-back bend placed so as to act on the last tooth in an arch will usually move that tooth away from the tooth immediately mesial to it without other aid. (*Fig.* 1.) If a series of tip-back bends is joined together to act on every tooth in a buccal segment, it is possible to tip a whole buccal segment distally provided always that an external force is added to the archwire, usually Class II or Class III traction depending upon whether the upper or the lower arch is involved. With this force the teeth will tip back from a point somewhere near their apices in favourable cases (*Fig.* 2). Without it they will be more likely to tip around the point of application of the force, which is the bracket. If the whole arch is to be moved distally, a means must be found of applying a distal-tipping force to the incisors as well, and this should be in harmony with the distal-tipping force on the teeth in the buccal segments. Since the labial segment of the archwire lies approximately at right angles to the buccal segments and to the sagittal plane, the tip-back effect will have to be bent into the cross-section of the wire instead of into the length of the wire if it is to maintain the same

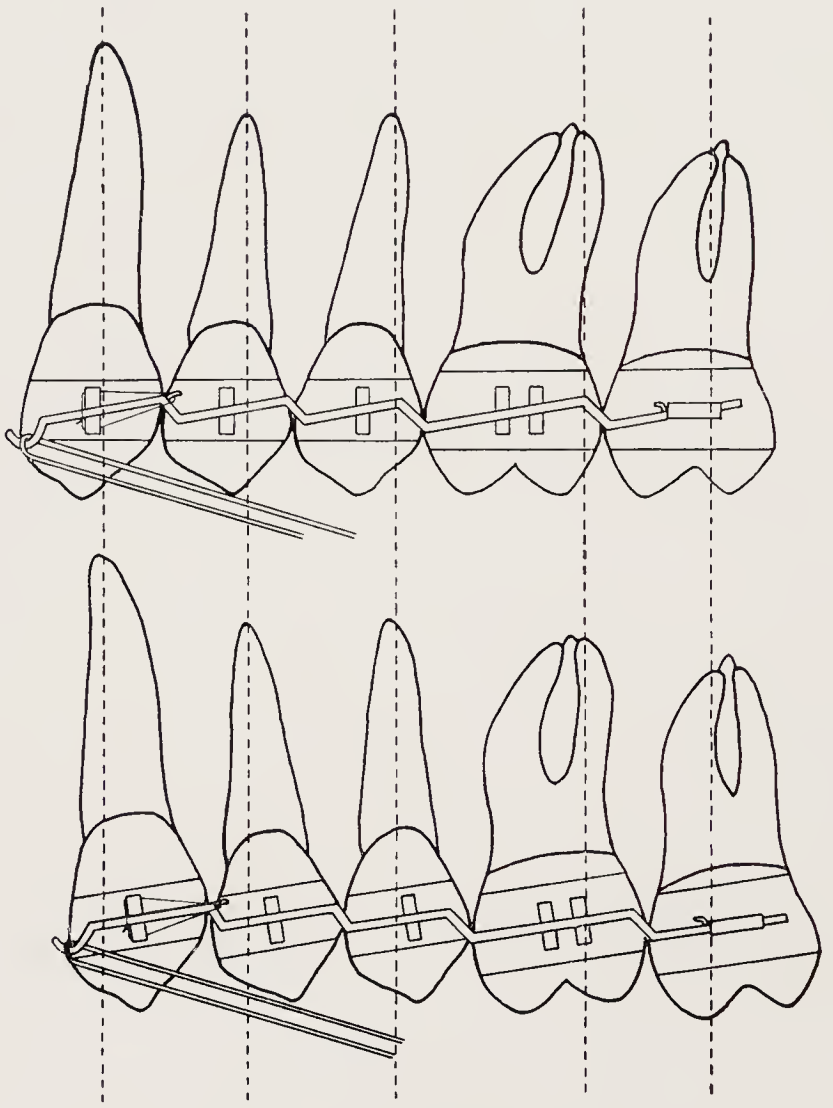


Fig. 2.—Tip-back bends plus Class II traction tipping the crowns of an upper buccal segment distally without forward movement of the apices.

direction. This is effected by seeing that there is lingual crown torque in the labial segment. (*Fig.* 3.) Tweed uses this movement regularly in the lower arch as well to prepare anchorage, for it both moves the crowns of the teeth posteriorly and gives them the distal axial inclination to resist pull that he desires; however, when he moves a whole upper arch distally to correct a Class II condition, once the upper incisors have been tipped to an æsthetically satisfactory inclination, at that point good mechanics is ignored and palatal root torque is substituted for palatal crown torque so as to prevent the upper incisors

from "rabbiting in" during the remaining distal movement; increased use of the head-gear plus Class II traction supplies the extra posterior-displacing force now required. He uses this mass movement of arches to correct non-extraction cases, and to correct extraction

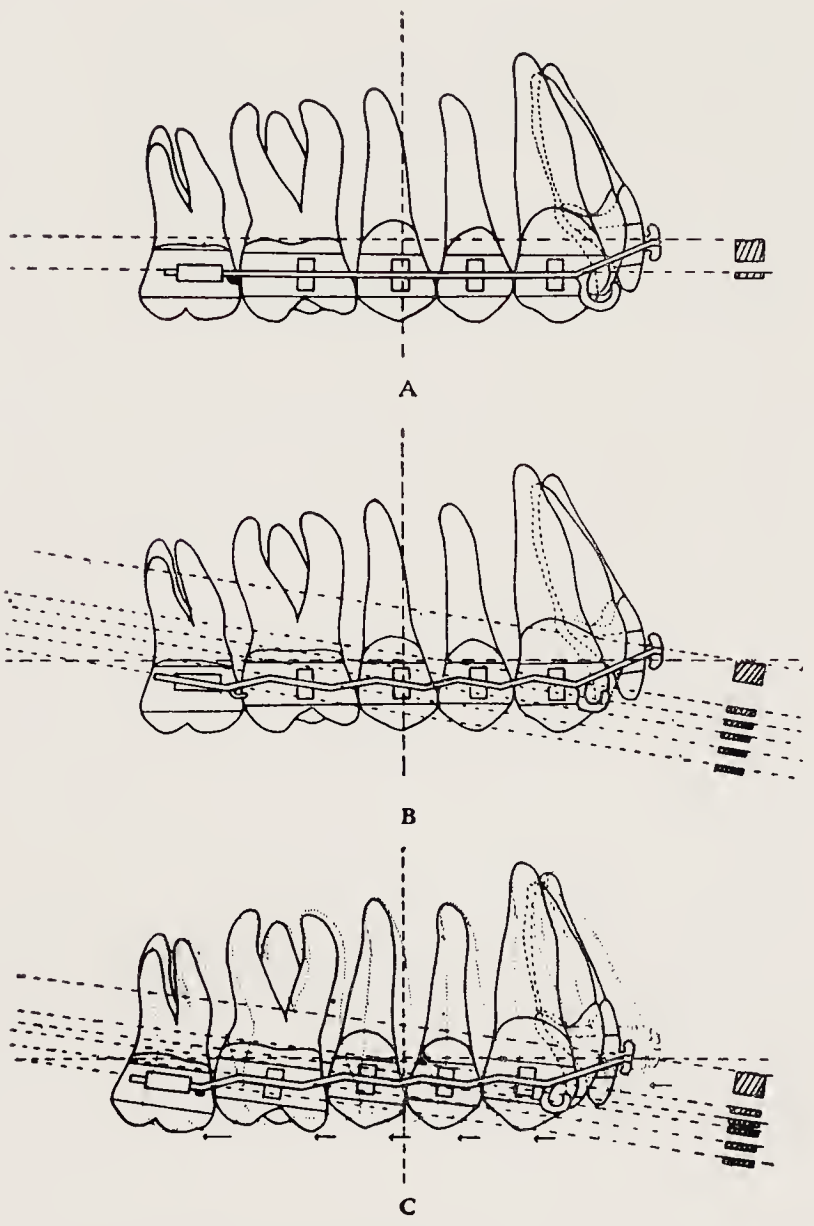


Fig. 3.—A, Arch wire in passive state; B, Correct co-ordinated second-order bends with incised torque; C, Illustrates action when intermaxillary force is applied to co-ordinated bends.
(*By courtesy of Dr. Charles Tweed and "The Angle Orthodontist".*)

cases after all the extraction space has been used up. In other words, if you have used up all your extraction spaces and there is still an overjet, the case may still respond to treatment as though it were a non-extraction case. With other appliances there is little else you can do.

With that introduction, I should like to describe how Tweed would treat the type of case mentioned at the beginning of this paper, a four premolar extraction case. As you will see, to try to cover the treatment in detail of all classes, extraction and non-extraction, would be an imposition upon your powers of endurance. Let us imagine that it is a difficult case, one requiring that two-thirds or more of the extraction spaces must be used up *from the front*, leaving only one-third or less of the space for harmless anchorage shift in the buccal segments. As you know, Tweed likes to end up with the lower incisors at an angle of 65° to the Frankfort plane because he likes the rather straight American cover-girl profile that such an angle tends to give, especially if it is associated with a low Frankfort-mandibular plane angle. This often means converting a mild overjet into a large one with subsequent bodily movement of the upper incisors to reduce it. Speaking for myself, and leaving aside considerations of æsthetics for a moment, I often try to do the same thing in order to reduce the degree of bimaxillary proclination of a case having incompetent lips, hoping that the competence or near-competence thus made possible will be in effect a new position of muscle balance and labial segment stability. If the profile is improved in the process, no one is more pleased than I.

To continue with the technique. After separation, all the teeth are banded, including the second molars if erupted. If the incisors are very imbricated, two only are banded at first, leaving the other two until room has been made by retraction of the canines. The bands are of precious metal and carry standard edge-wise brackets together with eyelets placed as far mesially and distally as the adjoining teeth will permit. The upper central incisors carry double-width brackets, and the first molars, when not the anchor molars, carry two standard brackets placed about $\frac{1}{8}$ in. apart. The anchor molars carry rectangular tubes and sometimes soldered hooks as well. (*Fig.* 4.)

The first step will be to level off the brackets so that the heavier rectangular wires may be sprung in without too much strain. Usually an 0·018 in. (i.e., 0·45 mm.) round arch is placed to accomplish this, and any rotations or slight buccolingual movements as well. Like all the archwires to be described, this one is of stainless steel, heat-treated, and polished. Every attempt is made to avoid proclination of the

incisors during this procedure, and it must be emphasized that the archwires are shaped to the malocclusion as much as it is required, with no similarity to the automatic rounding and proclining effect of the twin arch. Uprighting of the teeth in the buccal segments is started now, if they are at all tipped forwards,

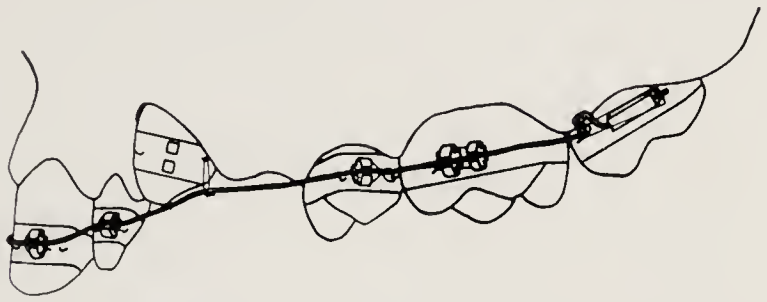


Fig. 4.—Initial correction of rotations and discrepancies in a vertical plane with a light round archwire.

by bends in the archwire. After three or four weeks, 0·019×0·026 in. (roughly 0·5×0·65 mm.) upper and lower arches are fitted (*Fig.* 5) carrying soldered horizontal loops;

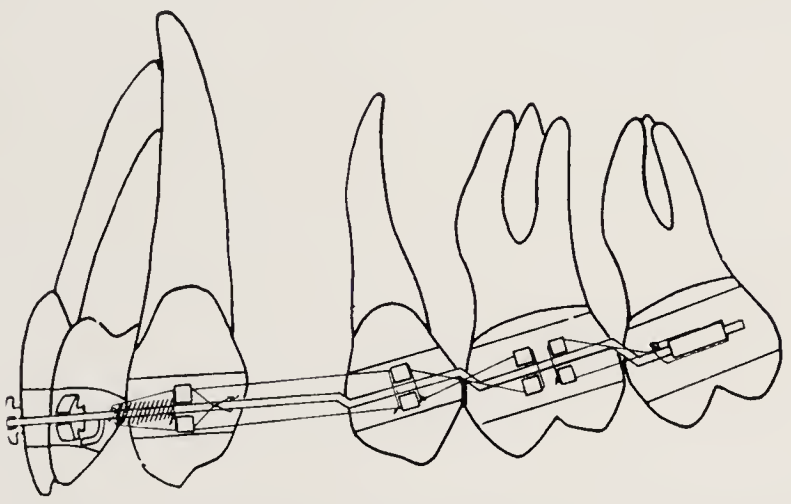


Fig. 6.—Appliance adjustment for the distal movement of upper canines with the aid of coil-springs.

note that the archwire is bent free of the canines and that the mesial arm of the loop is tied to the distal eyelet on the canines by the activating ligature; by this means the canine is free to tip distally and the tendency to rotate is minimized since the line of action passes nearly through the middle of the tooth. The headgear is used to the lower arch. When the canines have been moved distally until they are at right angles to the occlusal plane, further retraction is postponed until the teeth in the buccal segments have been tipped distally into anchorage-prepared positions, unless the case is a simple one with residual spacing. The upper arch is prepared to withstand the pull of Class III elastics by the fitting of an 0·0215×0·027 in. heavy stabilizing arch with mild tip-back bends in the buccal segments to hold them from tipping forwards, plus tie-back stops against the buccal sheaths

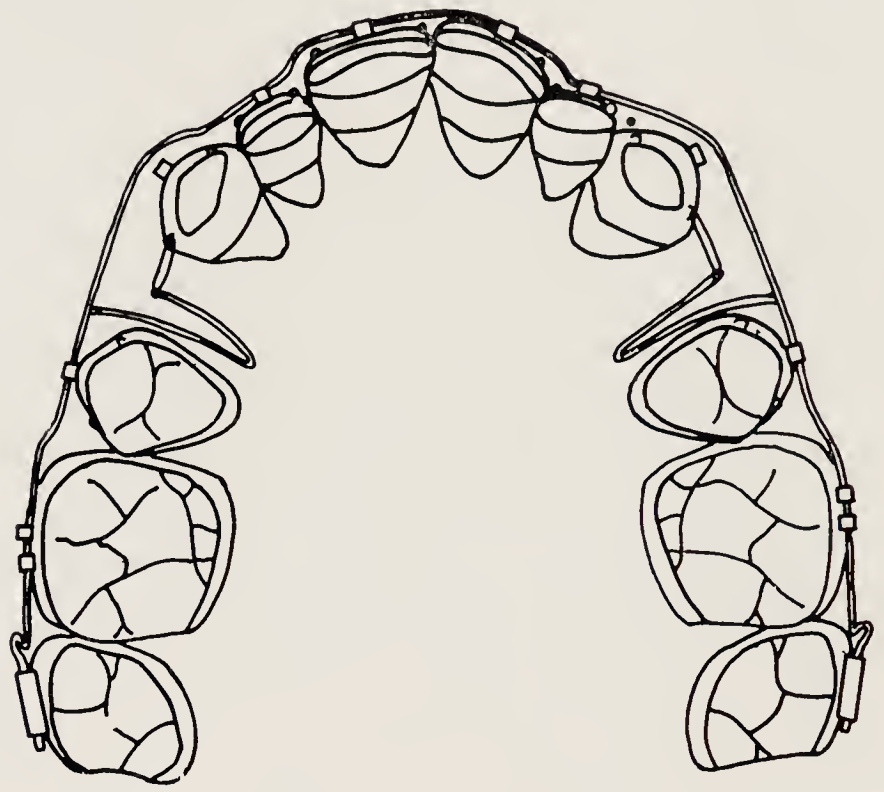


Fig. 5.—Appliance to tip upper canines distally until their long axes are at right angles to the occlusal plane.

and anterior brass hooks for the headgear attachment. It is tied back hard to bind the arch into a solid unit. The teeth in the lower

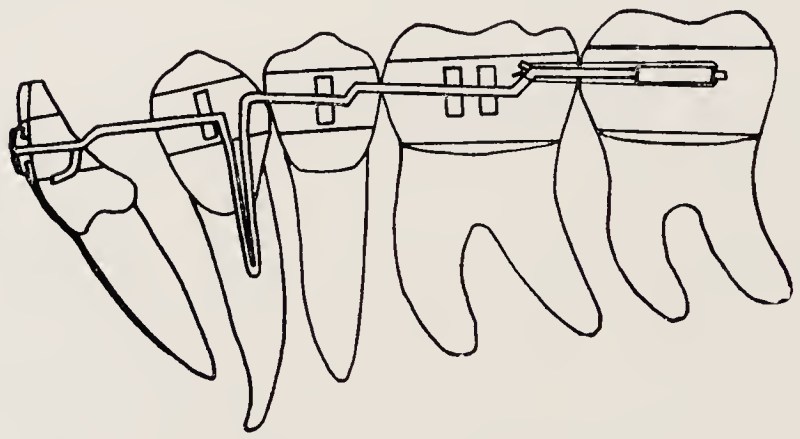


Fig. 7.—Lower Bull loop appliance for posterior movements of the labial segment. The tip-back bends in the buccal segments are bent immediately distal to the brackets to permit distal movement of the archwire under ligature traction.

buccal segments are tipped distally by fitting a working archwire (henceforth the 0·019×0·026 in. wire will be referred to as "working" and the 0·0215×0·027 in. wire as "stabilizing"), and this working archwire carries tip-back bends on the premolars and molars. The latter are induced to slide distally down the tip-back bends lying across their brackets by means of Class III elastics attached anteriorly

to sliding jigs, which are really a form of extended sliding hook made by bending short pieces of archwire to slide along the main archwire and press against the second premolars. Forward displacement of the upper arch is minimized by wearing the headgear

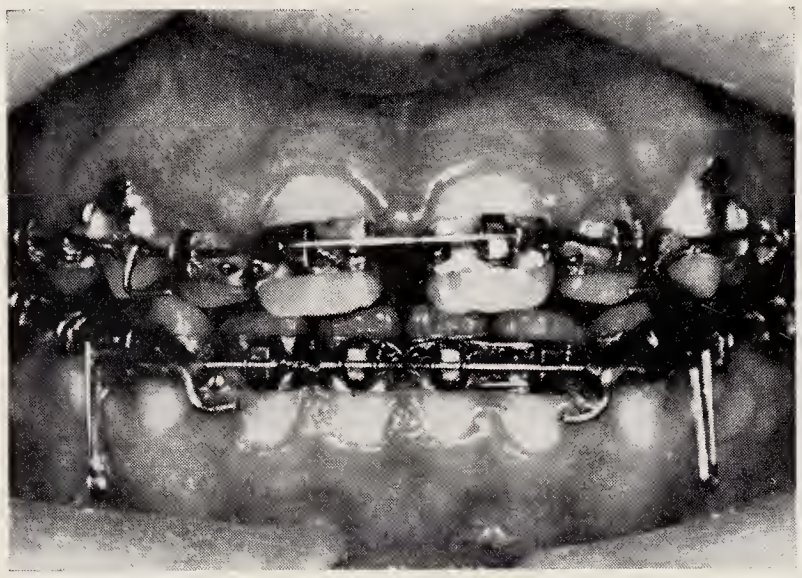


Fig. 8.—Lower Bull loop appliance adjustment shown with Class III elastics in place.

for at least fourteen hours out of every twenty-four. When the lower buccal segments have been tipped well back, the mechanics are reversed. A heavy stabilizing archwire is fitted to the lower arch tip-back bends and sliding jigs, activated by Class II elastics, take back the upper buccal segments into anchorage-prepared positions.

With the canines upright and the teeth in the buccal segments in anchorage-prepared positions, the distal movement of the upper and lower canines is continued by fitting upper and lower working arches carrying short lengths of open coil spring (*Fig.* 6). The archwires engage the canine brackets this time, the coil springs are activated by ligatures, and the canines are moved in an upright position as far distally as it is required. Should they take a distal tilt, the archwire is bent to move the apices distally while the coil springs hold the crowns from coming forward again. Once they are upright, the archwire is made straight again and retraction is continued.

With the canines back the required distance, all that remains now is to retract the upper and lower labial segments. The lower is retracted first, and this is done by fitting a lower Bull loop arch (*Fig.* 7) made from working archwire. Note that it is bent free of the canines, that the mesial leg of the loop is shorter than the distal so as to depress the labial segment, and that the loop is activated by tying a mesially placed tie-back stop to the distal of the buccal sheath so that it is pulled backwards. Hooks are soldered to the labial

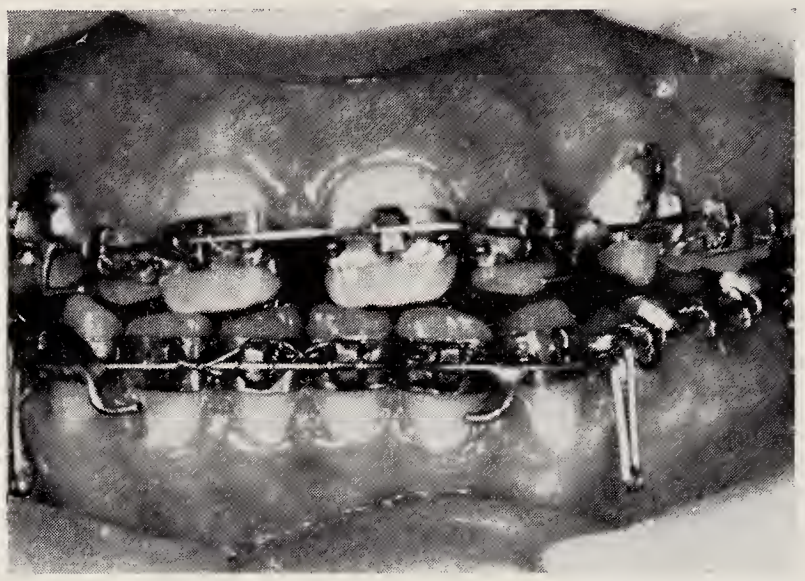


Fig. 9.—As in *Fig.* 8, but with an elastic removed to show a loop.

section of the arch, and the Bull loops, plus Class III elastics from an upper stabilizing arch plus headgear, as before, rapidly take back the labial segment as far as it is desired. *Fig.* 8 shows the case at this stage, and *Fig.* 9 the same case with an elastie removed for clarity. Tweed likes to take baek the lower incisors to at least 5° beyond 65° to the Frankfort plane, i.e., to at least 70°, as already stated. An ideal lower stabilizing size archwire now replaces the Bull loop archwire and Class III mechanics is continued until anchorage is well set up again in the lower arch. The lower archwire is then tied back hard to make it ready to receive the pull of Class II elastics.

The lower arch will now be used for the final retraction of the upper labial segment. Mechanics will be reversed once more, and Class II traction will replace Class III traction. With the retraction of the lower labial segment, the overjet will of course have been increased, but every effort will be made to maintain the lower incisors where they are. An upper Bull loop arch is fitted, and this, plus Class II elastics, is used to retract the upper incisors—but only until they are at an æsthetically satisfactory inclination to the vertical; from then on the Bull loop arch is discarded and

mechanics designed to maintain this æsthetically satisfactory axial inclination is substituted. In other words, bodily movement of the upper incisors must now be attempted if an overjet still remains.

The Bull loop arch is now replaced with a free-sliding stabilizing-size upper ideal archwire that will fit the bracket slots of the anterior teeth quite closely. (*Fig.* 10.) This absence of play is necessary because the labial segment carries strong palatal root torque so as to prevent the upper incisors from "rabbiting-in". It is bent quite free of the canine brackets, but in the buccal segments it is reduced to 0·018×0·024 in. in the anodic polisher so as to facilitate the free-sliding action through the brackets. The tip-back bends are carefully placed so as not to impede this distal-sliding movement, and, as you can see, intramaxillary traction from coil springs acting on stops soldered mesial to the premolar brackets is used to supplement the strong Class II traction and above all headgear traction that is essential at this stage. In Tweed's hands this method is so effective that he has to pay special attention to seeing that the upper incisor apices do not go through the palatal wall. If any spacing remains in the lower arch, advantage is taken of this to keep the lower incisors from proclining under the pull of the Class II traction, and this is done by having the lower tie-back stops on the lower arch placed a few millimetres mesial to the buccal sheaths and by cinching back hard at each visit so as to pull the incisors back the amount that traction has just displaced them forwards.

With the overjet corrected, fresh upper and lower ideal arches are fitted, and intramaxillary traction in both arches by means of open coil springs to forward stops is used to close any remaining spaces. These arches have been placed one on top of the other and carefully correlated bucco-lingually before being tied in. They also carry soldered vertical spurs so that up and down elastics may be worn to seat the cusps properly should that be necessary.

The bands are stripped in two stages: first the canine, premolar, and first molar bands are removed and intramaxillary traction continued until the band spaces have been eliminated; secondly, the remaining bands are stripped and impressions are taken for retainers. The spaces left by removal of the four incisor bands are closed immediately prior to taking the impressions, with two small

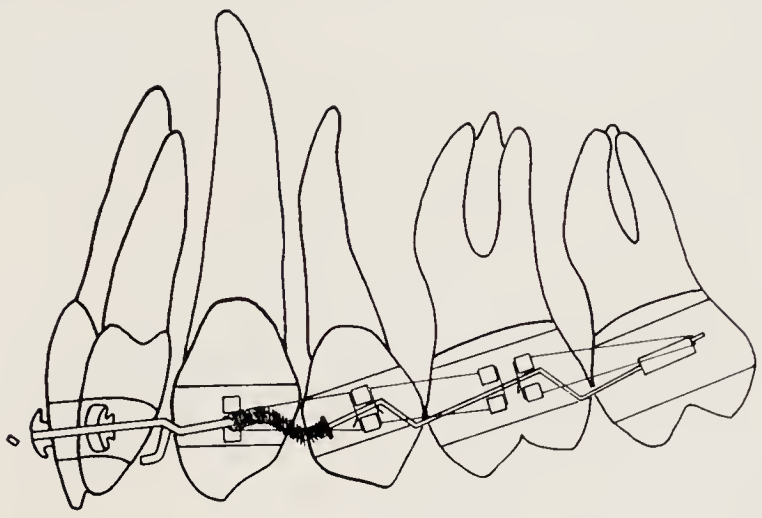


Fig. 10.—Appliance adjustment for the final posterior bodily movement of the upper incisors. The archwire is bent free of the canine brackets, and the tip-back bends are increased so as to maintain axial inclinations despite the reduction in size in the anodic polisher.

wedges, and the spaces thus opened up just mesial to the canines are utilized for passing the rectangular labial bow of the Hawley retainers from front to back. Cases are retained full time for one year and then at night for a further year.

SUMMARY

The edgewise is the most dangerous of all appliances in inexperienced hands, but when properly used it provides the best answer that we have to the treatment of the more difficult case. It can control the position of every tooth in the arch, and if a movement is possible at all, the determining factor is likely to be the skill of the operator rather than the limitations of the appliance. Its disadvantages are chiefly related to time. The time required by the patient to keep it clean, and the time taken by the operator to adjust it, with consequent limitation of the number of cases that can be treated. The first is not really a problem, and the second is something more related to economics than to orthodontics.

Case reports were shown, of representative extraction cases that had been treated within the last two and a half years. None were out of retention, so no claims were made

that the results were stable. The fact that they had mostly been treated according to Tweed's technique is incidental in this connexion. The aim was simply to show what tooth movements the appliance had brought about in the author's hands, so that the Society might have an idea of what it might achieve according to the philosophy and in the hands of a Tweed, of a Downs, or of a Brodie.

These cannot be included here but will be published separately.

Acknowledgements.—I should like to thank Dr. Charles Tweed for permission to describe the treatment procedures that are taught at his seminars, Professor Ballard for placing the facilities of his department at my disposal and for permission to show slides of those cases that were under treatment in his department, and Mr. W. J. Morgan, A.R.P.S., of the Eastman Dental Hospital Department of Photography for his skill in taking most of the photographs and preparing the slides.

REFERENCES

Ballard, C. F. (1951), *Trans. B.S.S.O.*; *Dent. Rec.*, **71**, No. 5.
Tulley, W. J. (1957), *Dent. Practit.*, **7**, 382.
Walter, D. C. (1953), *Angle Orthodont.*, **23**, No. 1.

DISCUSSION

The President said that he wished personally to congratulate Mr. Halden upon a very lucid exposition of a very difficult subject, and one which was particularly difficult to put over in the short time that he had had. He also wished to thank Mr. Halden personally for his efforts in bringing the edgewise technique to the Eastman. Although, as Mr. Halden said, they could not use it on their patients for eeonomie reasons, it was very important indeed that those in this eountry should know something about it.

One thing which had not emerged from the paper was the amount of time that Mr. Halden had spent originally making the brackets. Every one of them was carved out with hack-saws, abrasive disks, and so on, from half-round stainless steel wire. It was a very laborious business, but that was how Mr. Halden had started.

At the Eastman Dental Hospital they were grateful to Dr. Charles Tweed for inviting Mr. Halden over to the seminar and putting equipment at his disposal.

The President had much pleasure in calling on Dr. Stanley Rogge to open the diseussion. Dr. Rogge was a graduate of Illinois. He was in Britain as orthodontist to the Ameriean Air Force.

Dr. Stanley J. Rogge, in opening the discussion, said that he agreed with most of the points and techniques dealt with by Mr. Halden, but there were a few that he wished to discuss. His remarks did not represent differences between Mr. Halden and himself, nor was he saying that the technique as used by the various men mentioned by Mr. Halden was ineorrect and that his own was correct. It was just another way of doing things. He believed that one should try whatever technique one desired, whatever one happened to learn, and if it worked in one's own hands, that was fine. If it did not work, then one should switch to something else.

With regard to the use of molar width brackets in the eastern section of the United States, he had found that they did not always eliminate the need for staples to correct the rotations. It was true that some of the rotation was taken care of by the molar width brackets. However, he had had a number of cases transferred to him in which he had had to remove the bands and add staples and replace them. Consequently, he would prefer to add the staples before placing the bands in the first place. In that way one might save oneself trouble later.

The use of tubes on sixes and sevens in the lower arch was advocated by Dr. Townsend. He was fully in accord with that procedure and used it himself.

He was familiar with the views of Dr. Brodie. He was sure that it would be agreed that if the arch wires were removed after treatment was completed and the bands were allowed to remain and the case did not "pop", there was eertainly very little chance that it would after the bands were removed. However, he felt that some of the cases which "popped" or collapsed after the arch wires were removed and the bands were allowed to remain might not do so if, in addition to removing the arch wires, one removed all the bands, preferably as Mr. Halden had mentioned, in sections, either alternately or a certain section of bands and then the remainder. It was possible that the combined thickness of the bands might represent just enough space to prevent the ease from relapsing.

He would especially thank Mr. Halden for bringing out the point about the American views on influence of muscle physiology and muscle behaviour upon the aetiology of malocclusion. At the University of Illinois they had had seminars on this subject which included a discussion by Dr. Brodie. Some of the points which they considered were the tongue, the size, the position in the mouth at rest, and its action during swallowing. Secondly, they considered the lips. Were they loose and flabby or thin and tense as a drumhead? Thirdly, they considered the upper lip. Was it short and hypotonic? Fourthly, they eonsidered the lower lip. What action did it have during the patient's swallowing procedure? Did the lower lip have a tendency to crush the lower anteriors lingually and flatten the arch from cuspid to cuspid and at the same time to flare out the upper anteriors?

All those points were taken into consideration. Only Dr. Brodie and Dr. Downes were equally emphatic about the importance of the muscles and their effect on malocclusion.

With regard to the points made about the preparation of anchorages, being a graduate of Illinois, he first treated cases according to Dr. Brodie's method; namely, he disturbed the anchorage as littlc as possible. He had had a grcat deal of success following along those lines. He had not had to go in for other anchorages in either

extraction or non-extraetion cases. He was not saying that it was not necessary to do that, but he had not had to resort to that procedure. He had gone in for slight tip-back bands in the buccal segments posterior to the extraction spaee to keep the teeth upright when bringing them forward, and he had also plaeed slight tip-forward bands in the areas mesial to the extraction to keep the teeth upright when bringing them distally.

With regard to retracting the upper anteriors, he usually rested the areh wire—it was something they were taught at Illinois—on the incisors. As a rule, it probably fell just below the brackets and any distal force, either intermaxillary or extra-oral, on the buccal segments would give one the slight palatal tip action that one wanted. After one had attained the axial inclination of the ineisors that one desired, one would then go in for bracket engagements and lingual root torque as Dr. Tweed did in order to prevent there being a rabbit bite.

That could also be done very beautifully in Class II, division 1 cases treated with head eap or cervical strap by adjusting the stops on the bow in such a manner that one got very light action on the upper incisors, and when one reached the proper axial inclination one adjusted the stops in order to get more of the action on the molar tubes.

There were several ways of stripping the bands after the case was completed. Some persons preferred to strip the bands entirely and re-set the teeth, using a rubber tooth positioner. He liked to take off alternate bands.

With regard to the treatment of Class III cases, he was fully in accord with Professor Ballard's philosophy. He had done the same thing in the few Class III cases that he had treated.

With regard to the depression of teeth as mentioned by Mr. Halden, there were some men in Britain and in the United States who believed that they could not be depressed, but they really could, and lateral head X rays could prove that that was so.

In conclusion, he wished again to congratulate Mr. Halden upon his excellent paper, for it was one of the best that he had ever heard.

Mr. J. R. E. Mills said he thought that the edgewise arch undoubtedly had a place in their work. It had a precision of action which it was impossible to attain with any other appliance. In a small proportion of cases treated it could be a most useful adjunet. In Britain they had rather fought shy of it.

He wished to ask a question about the construction of Bull loops. He had used the edgewise appliance very little, but his experience using materials obtained in Britain—he got his materials from the same place as Mr. Halden—was that when he bent a Bull loop it usually broke at the point of bending either on the first occasion or a little later. He wondercd what was going wrong.

He had been interested in Mr. Halden's lingual movement of apices, and he wondercd whether Mr. Halden had any comment to make on pulp dcath or absorption of the apex.

Mr. J. H. Gardiner congratulated Mr. Halden not only on his excellent paper but on his work, whieh was of a very high quality.

He wished to ask Mr. Halden about the wire that he used and would like to know where he purchased it. Also, he wondered whether Mr. Halden found any difference between the wire purchased in this country and the wire available in the United States. From the samples which he had seen, there would seem to be a difference in tensility. He wondered whether that was due to the type of stainless steel wire used in the United States. Was it the austenitic type of stainless steel or the martensitie type?

Mr. D. T. Hartley said he had noticed that in some of the head plates there was an appreciable distal tilt of the lower second molars after treatment. Obviously, that was likely to result from the technique described. There seemed to be an inereased possibility of impaction eventually of the lower third molars. Could Mr. Halden comment on this point? He would also be glad if Mr. Halden would give details of the heat treatment and polishing of his stainless-steel wires.

Mr. B. C. Leighton said he had the impression that it was possible to move teeth to almost any position and that they would stay there provided that one retained the case for two years. Was he wrong in that impression, or was Mr. Halden's standard of æsthetics a particular standard which implied stability as well? Æsthetics was such a personal thing. What might be considered as æsthetic in Britain might not be so considered in America.

He had been a little surprised to hear a reference to the inclination of the lower incisors relative to the Frankfort plane. It seemed a little odd to refer the inclination of teeth of the lower jaw to a plane in the upper part of the skull.

He wondered whether any work had been done on the histology of the cases after treatment. Was there any damage to the pulp apart from damage to the bone?

He noticed that a high proportion of the cases were cases of bimaxillary protrusion, a condition not so frequently seen in Britain as in the United States. He gathered that the appliance was most suitable for those cases. Was it just as suitable for the other cases where there was a labial inclination of the upper incisors and lingual inclination of the lower incisors?

Mr. J. H. Hovell said he wished to make a request to Mr. Halden, and that was that he should show them the cases when they had been out of retention for five years.

Mr. H. L. Leech thanked Mr. Halden for his paper. He said he noticed in the Class II, division 2 case, Mr. Halden had found difficulty in getting the apices of the upper incisors back sufficiently to reduce any over-bite. He had had that experienee in treating cases with the Begg arch as distinct from the edgewise areh.

In most of Mr. Halden's cases the extractions had been the four first premolars or just the upper two first premolars.

Did Mr. Halden, in eases where there was little crowding in the lower jaw, consider extracting the lower second premolars rather than the lower first premolars?

Mr. J. D. Hooper asked Mr. Halden whether he had any idea of the actual surgery time he expected to use in every case.

The President said that, before he asked Mr. Halden to reply, he would like to say a word in support. Although Mr. Halden had shown cases which were not out of retention—that was because he had started the cases since he had returned from the United States—they had some very good cases at the Eastman which Mr. Halden treated before he went to the United States which had settled down very well out of retention.

When he was asked to open the discussion Dr. Rogge said he did not like to do so because he would like to take part in the general discussion. If Dr. Rogge had

anything to say in relation to what went on in America, he was sure they would all like to hear it before Mr. Halden replied.

Dr. Rogge said that Mr. Halden had covered fairly well what went on in America. The Tweed philosophy was very popular. Even Illinois and Northwestern men were taking the Tweed course.

Mr. Halden, replying to the discussion, agreed with what Dr. Rogge had said about molar width brackets. In many cases he would like staples on these bands too. One of the advantages of having molar width brackets on all teeth was in preventing rotations which might otherwise occur, rotations which one did not want and which were not there to start with. If one did a lot of cinching up to get the maximum retention on the arches one was liable to squeeze a tooth so that it started to rotate. The edgewise bracket was very narrow, and just tying it into an arch was not suffieient to prevent the tooth from rotating any more than tying it into the areh was sufficient to rotate it.

An expert in America reeommended putting molar-width braekets on the bands on the second premolars, on the canines, and the upper central incisors, and that was becoming the fashion in the United States.

With regard to putting tubes on the sixes and sevens as advocated by Mr. J. R. Thompson, the only trouble was that if one was putting a tip-baek band on the last tooth one could not get the arch in because the tip-back band would aet as a stop and would not slip through the tube. It was fine if one did not want to use those particular mechanics, but no good if one did.

With regard to Dr. Brodie's method of taking off the bands and seeing whether the ease "popped", that was fine, but what did one do if it did? One would have to put all the bands back again, and many patients would not be happy about that.

As to musele physiology and anatomy at the Dr. Brodie seminars, he had sat in on these seminars. Dr. Brodie did relate it to the aetiology of maloeclusion.

With respect to anchorage preparation and Dr. Brodie's results, he had seen some of the results, and they were beautiful. He would like to use the method more. It was a matter of the way one was taught. Dr. Rogge liked to take a case and build the occlusion, more or less as he would, round the stable position of the lower labial segment.

With regard to band stripping and the Kesling Positioner, he would like to use this arrangement, but there were not the facilities in this country. In the only attempts they had made, the rubber had been so unpleasant that they had not sueeeeded in getting the patients to wear the appliances.

He would have thought that if anyone could cope with the edgewise arch it would be Mr. Mills.

With regard to the construction of Bull loop arches and their breaking, he had had that trouble too, although he did not usually use what the Americans called a mashed loop but put a slight curve in the top.

He had brought back some stainless steel wire such as was used in the United States and sent it to the Stainless Steel Wire Company and said "Please reproduce the properties of this wire". Up to that time he had been having trouble with the wire, which was too brittle, and it had a rectangular section coming almost to a knife edge. Dr. Tweed used wire with rounded corners. If Mr. Mills bought his wire from the Stainless Steel Wire Company and specified the quality supplied to the Eastman, he would not have any more trouble.

With regard to bodily movement, pulp death, and absorption, he had not yet had a case of pulp death and had not heard of one. Absorption had, however, to be watched. It was true that the appliance was liable to cause more absorption than others, but one could see from the slides how much apical absorption there was. He had seen only a rounding, which was slight, particularly in comparison with the other advantages that were gained from the use of the appliance.

Those who had had experienee of the retracting of incisors in many of the ways that were practised in this country would know that the upper incisor apices usually went forward, and there was no better way of doing an apicectomy on upper incisors than by that method. The upper incisor apiees would go forward to the A point and dissolve. They did not go through. By comparison the edgewise method shown was much safer for retraction of upper incisors.

Mr. Gardiner had asked where he purchased his wire. The answer that he had just given to Mr. Mills would cover some of Mr. Gardiner's question. He used the Stainless Steel Wire Company's rectangular wire, and speeified that it should be of the type he wanted. If anything, it was a little too soft, and he might ask the Company to toughen it up a little. The wire supplied by the Company was about identical with the wire which he had brought back from the United States. He had since been supplied with some Unitec wire, which seemed to be tougher, but until he had used it he could not eomment on it. The Stainless Steel Wire Company's wire was of the 18/8 stainless steel type.

With regard to Mr. Hartley's question about distal movement of molars in treatment and impaction of lower eights, he would like Mr. Hartley to ask him that question in some years' time. He was not in a position to answer the question because he did not know the answer. He imagined that it would be more likely to impact the lower eights.

Not everybody agreed that heat treatment was a good thing, but he thought there was a big swing that way at the moment. As far as hc remembered, one heat-treated at 800° F. for three or four minutes.

Polishing was done in an anodic polisher. The equipment could be made cheaply, but one could spend a lot of money on it. It was essential if one was going to thin a section of the areh wire only.

Mr. Leighton had spoken about æsthetics and stability. To give Dr. Tweed's views on that subject, he had been keen on the lower incisors being up on the basal bone, but now he was rather veering to having them at 65° to the Frankfort plane. One had to read Dr. Tweed's article and agree with him or not. As to how Dr. Tweed came to his decision, he selected a group of patients purely on the basis of their profiles. He was not interested in anything else for this investigation. Some of the patients were young and some were in their forties. Dr. Tweed then seleeted the type of profile which he himself had described, which was typified by the American cover-girl profile. He took head plates and found that the angle of the lower incisors in these cases was 65° to the Frankfort plane, $\pm 35°$. Dr. Tweed had based his philosophy of æsthetics on that point. In any case, if one tipped the lower incisors forward, one was lucky if they did not relapse afterwards.

As to the histology, he did not know whether any work had been done.

With regard to bimaxillary protrusions, apart from one case which had already been under treatment a

long time, the cases were all English children and they were treated here. He believed that Professor Ballard found that bimaxillary protrusions became more common in London during the war years and believed that it was due to the influx of Middle European refugees bringing in different morphological types. He would agree with Professor Ballard on that. He thought the bimaxillary protrusion was a much more common morphological type in America than it was in Britain.

As to whether the appliance was useful for bimaxillary retroclinations, he would have thought that it was equally useful. His purpose had been to show what tooth movements the appliance could bring about so that one could suit it to one's own philosophy.

He thanked Mr. Hovell for his remark! He had expected far worse from him. He, too, would be very pleased to see the cases in five years' time. He was just as interested in it. He had had just as many doubts in some cases as Mr. Hovell had, but he thought it was something that had to be done. How could they argue with or agree with the American methods unless they reproduced the same results and saw what happened?

With regard to the remarks of Mr. Leech about extracting the lower second premolars instead of the first premolars, he had not done that yet. Some periodontologists did not consider the lower first premolars to be anatomically suited to the position of contact with the lower first molar. The second premolar usually had a flat distal surface and the first premolar had a rounded distal surface. He thought it made the treatment a lot harder. However, in a case where one needed only a little space, he would prefer to take out the lower second premolars rather than the lower first for a straightforward job, and not to retroeline the lower incisors.

As to the remarks by Mr. Hooper, he had no figures at all to show how long he had spent on cases. He would not like to time himself until he had been doing the treatment for a longer time. However, some were done very quickly indeed.

The President said he believed that those who had taken part in the discussion had expressed the general feeling of the meeting, that they had listened to one of the best papers that they had heard for a long time. The paper was even more commendable because it was on a difficult subject.

They must also thank Dr. Rogge for opening the discussion. It was very appropriate indeed that they should have someone from the other side of the Atlantic to do so.

The thanks of the meeting to Mr. Halden and Dr. Rogge were unanimously accorded by acclamation.

A STUDY OF THE GROWTH IN HEIGHT OF THE ALVEOLAR PROCESS: O'MEYER'S SIGN

By **R. X. O'MEYER**, *Paris*

Facial growth has been an extensive field of investigation during the last thirty years, that is, since the coming of teleradiography and the perfecting of it by Broadbent.

Anatomists and anthropologists have been concerned with this subject, but more from its ethnical standpoint than its additional stages.

The author has recalled the history of the research carried out in the course of time on facial and alveolar moulding (O'Meyer, 1954). Certain opinions have been, and still are, divergent with regard to utilizing and interpreting the information contributed by cephalometry, but to deny or dispute the value of the works of Ballard, Broadbent, Brodie, Downs, Hovell, Ricketts, Rix, Steiner, Thompson, and others would be going rather far into the field of scepticism.

While we may not be always absolutely certain about the mathematical value of cephalometric measurements, they come very near to the truth, and I think that any error comes from the human side. During a recent discussion at the Société Française d'Anthropologie, I recalled the precautions taken by Brodie during the research work that he carried out on facial and cranial growth: (1) On dry skulls, the positioning of metal sighting marks on the anthropological points and those used in orthodontia; (2) Metric measurements of the distance between the various points; (3) The taking of teleradiographic films and measurements between the points previously considered.

The margin of error was insignificant.

We know the various chronological stages of growth in general. Facial growth may be considered to resemble a tree where the growth is characterized by large stages and seasonal periods, the latter being capable of being divided up into six parts:—

1. Infancy (birth–3 years);
2. Second infancy period (3–6 years);
3. Third infancy period (6–10 years);
4. Pre-pubescent and puberty period (10–14 years);
5. Post-pubescent period (14–17 years);
6. Nubility (17 years–maturity).

Slight variations correspond to all these periods according to the sex under consideration, the region studied, and the presence or otherwise of orthodontic treatment. Farther on we shall observe the importance of those various factors. The elements forming facial structure are multiple, and their growth does not appear in synergy. If we consider the upper part of the face, we observe that the eyes and the nasal fossæ fulfil their function right from birth, whereas the lower part, characterized by the mandible, only starts up much later and is partially dependent on dental eruption. That is why mandibular growth seems to be more active than maxillary growth, which is motivated by the slowness exhibited by the mandible during fœtal life.

Out of all this assembly of bone growth we shall confine our investigations to alveolar growth.

WHAT IS THE ALVEOLAR PROCESS ?

Black (1902) defined the alveolar process as: "The bone projection which grows around the roots of the teeth and forms the cavities in which their roots are secured by their ligament." John Hunter gave the similar definition, when he wrote:

> "The alvcolar processes of both maxillaries should rather be considered as belonging to the teeth than as parts of the jaws; for they begin to be formed with the teeth, keep pace with them in their growth and decay and entirely disappear when the teeth fall; so that, if we had no teeth it is likely we should have no sockets, but not even these processes in which the sockets are formed; and the jaws can perform that function and give origin to muscles without either the teeth or alveolar processes. In short, there is such a mutual dependence of the teeth and alveolar processes on each other that the destruction of the one seems to be always attended with that of the other."

Given at the meeting held on March 11, 1957.

Ever since Hunter wrote the above in 1771 there has been controversy over whether the alveolar processes should be considered as part of the jaws. Anatomically, no distinct boundary exists between the body of the maxilla or mandible and their respective alveolar processes.

"In some places the alveolar process is fused with and partly masked by bone which is not functionally related to the teeth. In the anterior part of the maxilla, the palatine process is fused with the alveolar process. In the posterior part of the mandible the mylohyoid bone line is superimposed upon the bone of the alveolar process." (Orban, 1944.)

Brodie (1934 a) wrote:—

"At birth, the face has the following appearance: the hard palate or floor of the nasal fossæ is at a level slightly below the orbital floor. The orbital cavities are well developed in size and their floor literally forms the base of the alveolar process. At this stage, the latter is only shown by a ridge surrounding the hard palate, and the maxillary sinus is a simple groove situated close to the lateral wall of the nasal cavity. In this confined spot, limited above by the orbital floor, in the middle by the nasal wall and below by the alveolar fissure, there lie, close to each other, the germs of all the teeth of the maxillary, with the exception of the second and third permanent molars.

"The growth of the alveolar processes contributes far more to the length of the face than all the other factors. The bone is widely extended over the crest and on the lateral surface of the process and is speedily converted into spongy bone, so that this bony area forms a continual centre of activity during the growing period."

This would appear to be confirmed by what MacMillan (1924 a, b) stated:—

"The alveolar process varies with the length of the cuspids, the angles and inclined planes, the axis of the forces, the loss of teeth, the masticating forces, etc. . . . and all these factors are in their turn in relation with the shape of the glenoid cavity and the condyle."

Continuing his research work, the same author observed in 1927 that an abnormal alveolar process might correspond to closing surfaces showing a certain degree of abrasion. Commenting on the individual relative proportions of long and short faces, Brash (1924) wrote:—

"It is evident that the principal factor in differentiating between these two extreme types of face, may be found in the increase of growth in length, with an increase of the proportions of alveolar bone."

With the same ideas in mind Sicher and Weinmann (1947) wrote:—

"Downward and forward growth of the sub-nasal part of the maxillary is accompanied by an intensive affixing of bone in this area and contributes, not only to the increase in length of the upper facial framework, but also enables the normal adjustment of the alveolar process with the dental arch, which is specially necessary at the time when dentition changes."

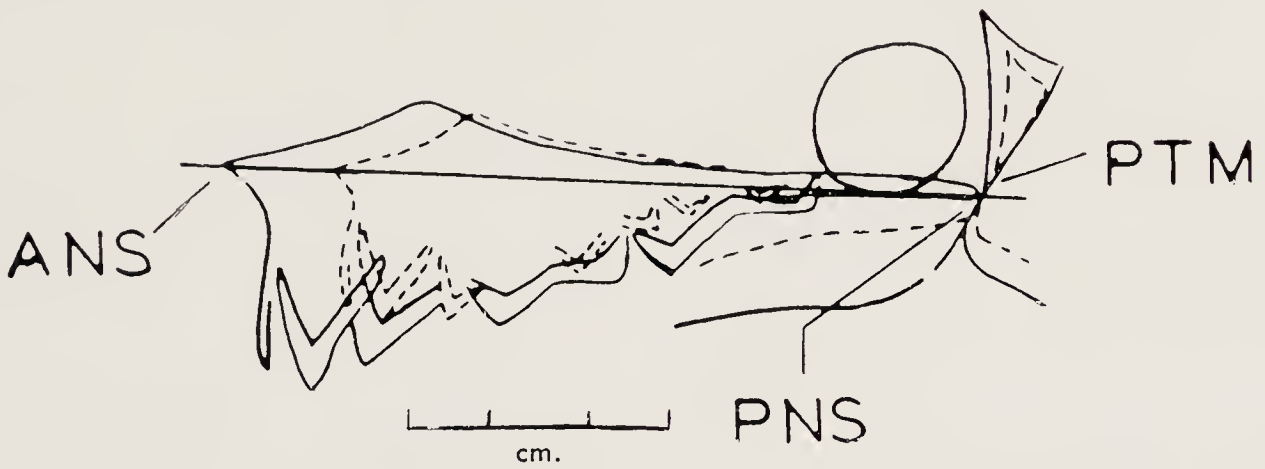


Fig. 1.—Diagram to show growth of alveolar process and fixed points.

Brabant shows that:—

"The bony bridges direct themselves according to the best principles of architecture for shouldering the alveolar edges. When the canine teeth erupt, the external table thickens opposite to them, whereas the base of the column thus formed widens. The eruption of the molars is accompanied by a strengthening of the cheek-bone and tuberosity: the maxillary sinus, which is very small in the child, then attains to its final expansion. The modifications of the alveolar processes are still very much more important. They continue throughout the duration of final dentition, in spite of fixing the term of bony growth at six years."

Ortiz, in his thesis (Ortiz and Brodie, 1949), observed:—

"At birth the alveolar process is practically non-existent and its inferior surface lies only slightly below the level of the palate. The pterygoid process descends to this same level at its junction with the maxilla, while its inferior border runs downward and backward so that the hamular process at its postero-inferior extremity is carried to a still lower level. . . . From birth onward the alveolar process descends at a much higher rate than does the pterygoid process." (*Fig.* 1.)

We will now observe how the alveolar bone behaves during facial growth. We can perceive that this bone develops in three dimensions.

Brabant says:—

"In length, it converts the profile of the child by lengthening the lower part of the face. Its widening, which is not very marked on a level with the milk molars

because they are replaced by smaller premolars, may reach, on a level with the incisors, 30% of the primitive width. In length, the eruption of the molars, helped by a powerful mesial movement, will cause an appreciable change in the alveolar edge."

In the general opinion of research workers from John Hunter to the present day, the process of replacing milk teeth is associated with the destruction of the alveolar process which sustains them and the eruption of the permanent teeth testifies to the construction of a new alveolar process.

To show this by starting with telecephalometric examination has been the object of the research work that I have undertaken.

METHOD EMPLOYED

The various points, lines, planes, and angles employed are illustrated in *Fig.* 2.

The anterior nasal spine (ANS) is easily ascertained and located, but the posterior nasal spine (PNS) may be hidden in certain pictures by a tooth in the course of formation or about to erupt; although in many cases the floor of the nasal fossæ is visible from one end to the other of its extent, in doubtful cases we can locate PNS by basing it on the attaching point to the soft palate.

With regard to the mandible, the profile is usually clear and distinct and it is only necessary to determine which points we shall utilize for making quantitative measurements.

The gnathion (Gn) is obtained by bisecting the angle formed by the tangent lines, one at the most deviated point, the other at the most projecting point of the mental symphysis. Assuredly this is an arbitrary point, but it is constant and more easily located than a hypothetic gnathion.

The determining of the gonion (Go) is obtained by bisecting the angle made by the tangent lines at the posterior and lower edges of the junction of the mandibular body with the ramus.

When two pictures appeared, which is almost the rule, the mean was utilized.

Each radiographic examination of the head, of all the series, was drawn on fine acetate paper with a hard pencil.

Very special attention was paid to the maxillary part placed under the floor of the nasal fossæ and for the mandibular body, because these areas form part of the dental field.

The following points and planes were drawn up for taking the measurements (*Fig.* 2).

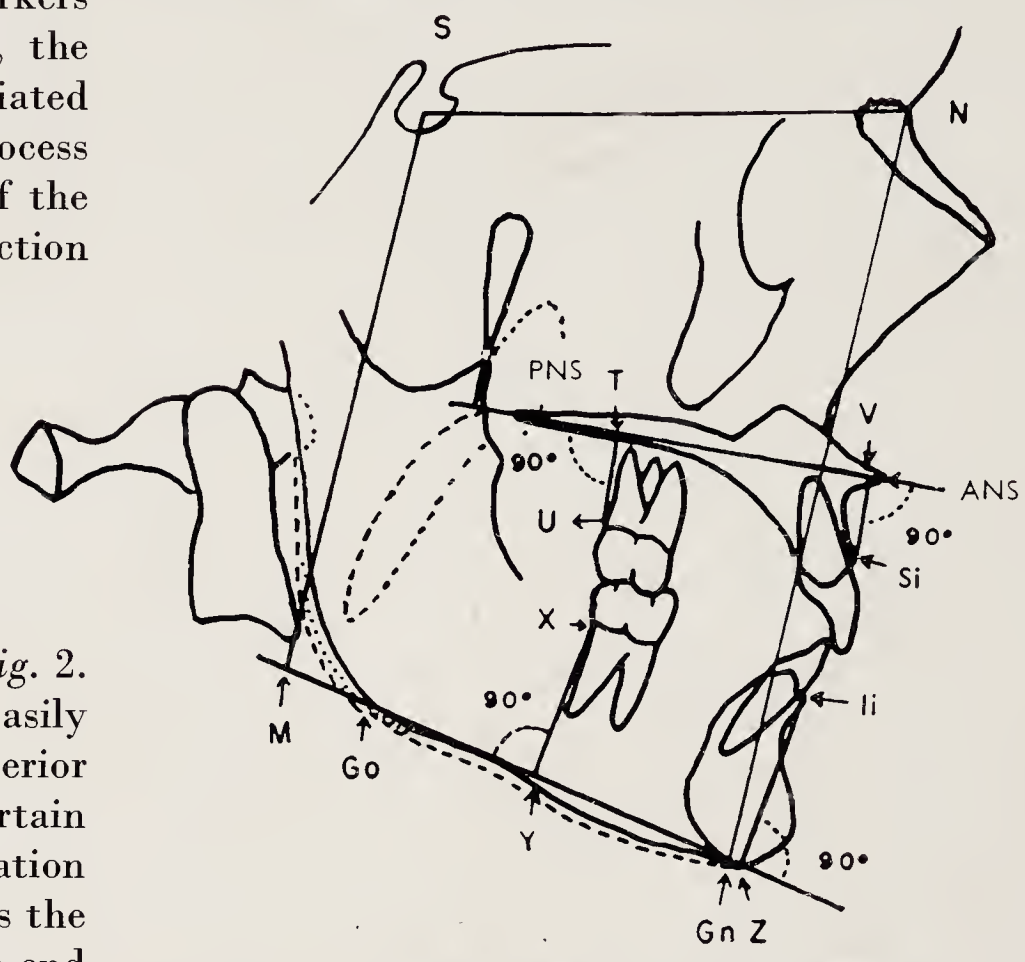


Fig. 2.—Tracing made from lateral headplate, showing the various points and areas studied in this investigation.

Explanation of Abbreviations used in the Text and Illustrations.—

Points:

ANS, End of anterior nasal spine;

Gn, Lowest point on silhouette of mandible at symphysis;

Go, Point of bisection between most inferior and posterior points on angle of mandible;

Li, Crest of alveolar process at lower central incisor;

M, Point of intersection of line dropped from S intersecting plane Gn–Go and parallel to N–Gn;

N, Fronto-nasal junction;

PNS, End of posterior nasal spine;

S, Centre of sella turcica as located by inspection;

Si, Crest of alveolar process at upper central incisor;

T, Point of intersection of perpendicular from U to plane ANS–PNS;

U, Crest of alveolar process distal to upper first permanent molar;

V, Point of intersection of perpendicular from Si to plane ANS–PNS;

X, Crest of alveolar process distal to lower first permanent molar;

Y, Point of intersection of perpendicular from X to plane Gn–Go;

Z, Point of intersection of perpendicular from Li to plane Gn–Go.

Planes:

ANS–PNS, Line connecting anterior and posterior nasal spines and representing nasal floor;

Gn–Go, Line from Gn to Go representing lower border of mandible.

All measurements were read with correctional scales; where right and left images did not exactly superimpose the measurements were made to the point of bisection between them.

The height of the alveolar process was measured in four areas, viz.:—

1. Upper central incisor (Si–V);
2. Lower central incisor (Li–Z);
3. Upper first molar (U–T);
4. Lower first molar (X–Y).

Total anterior dental height was read between V and Z and total posterior dental height between points T and Y. Total anterior facial height was read between N and Gn and total posterior facial height between S and M.

This study was restricted to that period beginning with the eruption of the first permanent molar and the permanent central incisor. X rays of the period covering the eruption of the deciduous dentition, although revealing the teeth clearly, were not similarly reliable in the delineation of the alveolar crest which it was desired to study.

Several cephalograms on the eruption period of milk teeth were rejected, for, while the teeth were generally visible, the alveolar processes were not.

There is nothing of interest to report posterior to the deciduous molars. This area gradually accommodates itself for the eruption of the first permanent molars.

On the other hand, the change that accompanies the falling out of the temporary incisors and their replacement by permanent teeth is most interesting. In that area there is a distinct reduction in the height of the alveolar process to be seen before the central deciduous incisor falls out.

That is why the measurements of the molar and incisor area were taken just before replacement commenced.

The extent of the variation in age was so great when falling out had commenced that synoptic tables were drawn up according to the years of eruption taken as basic age, zero being the point where reabsorption had reached its extreme limit and where the growth of the alveolar process upwards recommences its reconstruction. The measurements before that stage are marked with a minus sign.

FINDINGS

As would be expected during this period of life, all dimensions measured showed increase. Certain sex differences were also differences found between treated and non-treated cases.

Table I.—Sex Differences

Sex	Alveolar Process	Increase		Decrease	
		Mean in mm.	Mean in mm.	Mean in mm.	Mean in mm.
M.	Lower post.	7·5	2–13	—	—
F.	Lower post.	4·5	2–7	—	—
M.	Upper post.	11·5	6–17	—	—
F.	Upper post.	10·5	5–14	—	—
M.	Lower ant.	8·0	4–11	2	1·0–3
F.	Lower ant.	6·0	4–10	3	1·5–4
M.	Upper ant.	5·5	1–10	3	1·0–10
F.	Upper ant.	6·5	3–12	5	2·0–7

We know that the skeleton undergoes the influence of sexual hormones, the face and the cranium not developing at the same rate with a girl as with a boy, and finally showing small morphological differences (Brabant).

Sex Differences.—Growth in height of all parts of the alveolar process is definitely greater in the male. The total increase in anterior dental height of the female for the mean of the sample was 6·95 mm., while the males exhibited a growth of almost twice as much, viz., 12·71 mm. Similar, but not such great difference, was noted in posterior total height, the females increasing 11·44 mm. and the males 15·89 mm. It will be noted that both sexes showed the gain in total posterior height to be greater than total anterior height.

Turning to specific areas (*Table I*), it was found that the male exceeded the female values everywhere except in the upper incisal region, where the mean female value was 6·5 mm., with a range of 3–12 mm., while the mean value male increment was 5·5 mm., with a range of 1–10 mm. The mean values for lower anterior and upper posterior heights were not greatly different—male 8 mm., female 6 mm. and male 11·5 mm., female 10·5 mm. respectively. The ranges were quite similar.

The greatest difference was noted between the sexes in thc lower posterior region where the males yielded a mean of 7·5 mm. as against 4·5 mm. for the females. The range of this measurement was considerably greater in the male than in the female, however.

The greatest number of cases studied did not extend beyond the sixteenth or seventeenth year of life and at these ages all were still growing. A few cases for which records were available to the twenty-first year showed limited growth to that age. These were all males and therefore it was impossible to determine whether there were sex differences at the time at which growth ceased.

Differences in the Value of Growth.—In the boy, as in the girl, the difference observed in the value of growth was extremely great. In some cases thc alveolar crest showed a steady increase in height from one end to the other of the period studied.

In other cases growth increased by 1–2 mm. after the complete eruption of the teeth. It was by analysing these data that we were able to establish a correlation with the difference in quantity of the total growth of the face in length, but a correlation of this kind proved to be really vague. This is to be regretted, for it might have enabled the question to be solved of knowing to which parts growth

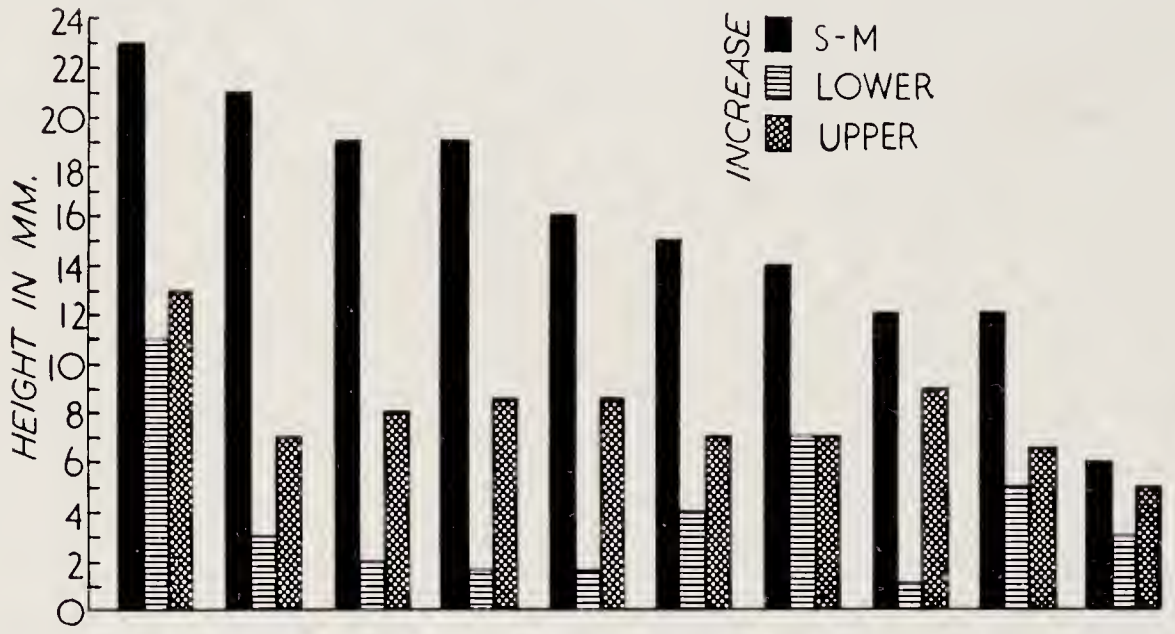


Fig. 3.—Diagram showing relative increase in posterior alveolar height, upper (T–U) and lower (X–Y), and total posterior height (S–M) in the female. Data arranged in order of decreasing magnitude of S–M show lack of correlation.

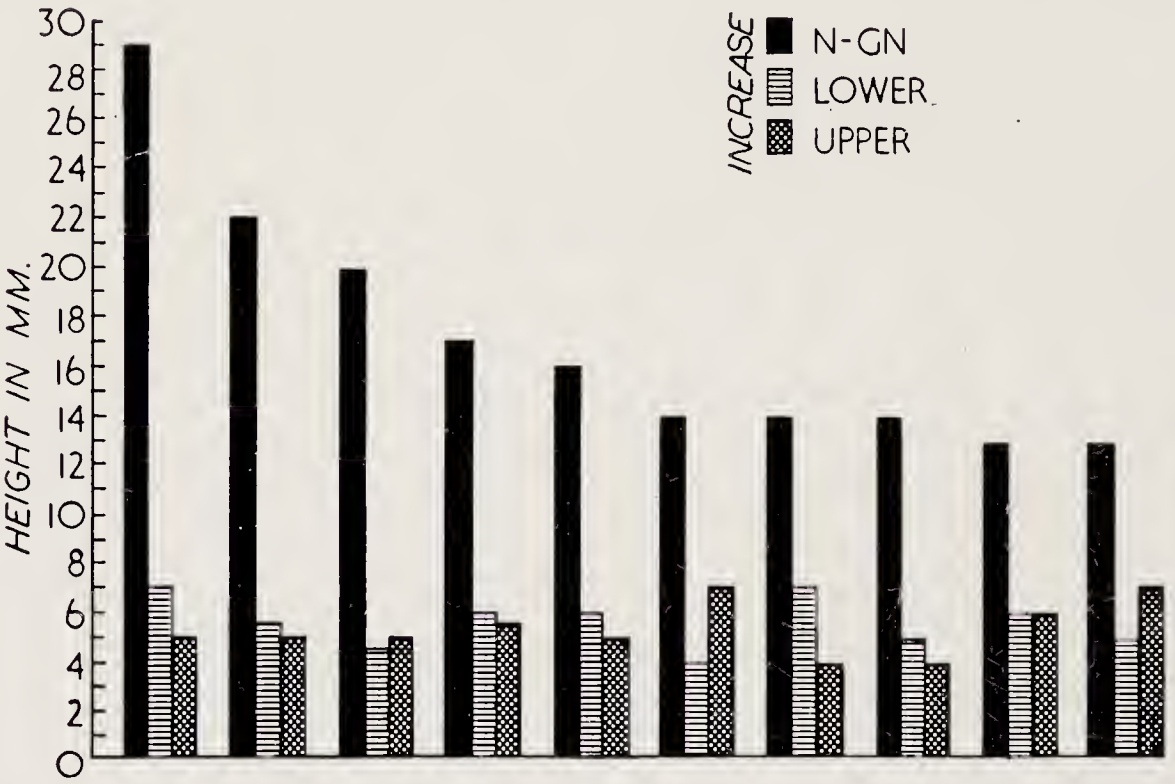


Fig. 4.—Diagram showing relative increase in anterior alveolar height, upper (V–Si) and lower (Z–Li), and total anterior height (N–Gn) in the female. Data arranged in order of decreasing magnitude of N–Gn show lack of correlation.

exactly belonged quantitatively in the length of the face.

The following diagrams show the relative growth of the masculine and feminine alveolar anterior 6 mm., posterior 4·5 mm.; Male, lower anterior 8 mm., posterior 7·5 mm. The range was about the same in both, as will be seen in *Figs.* 6–9.

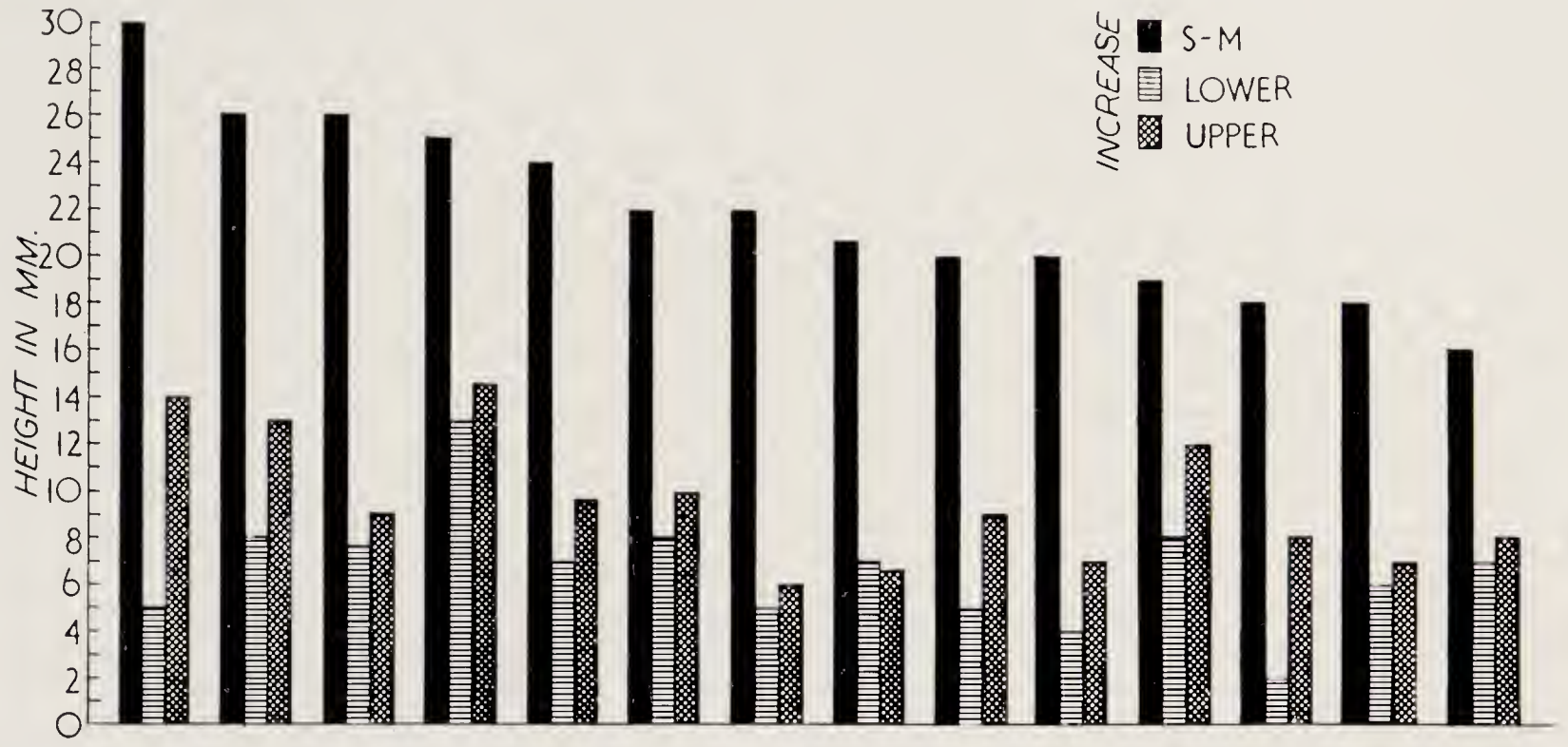


Fig. 5.—Diagram showing relative increase in posterior alveolar height, upper (T–U) and lower (X–Y), and total posterior height (S–M) in the male. Data arranged in order of decreasing magnitude of S–M show lack of correlation.

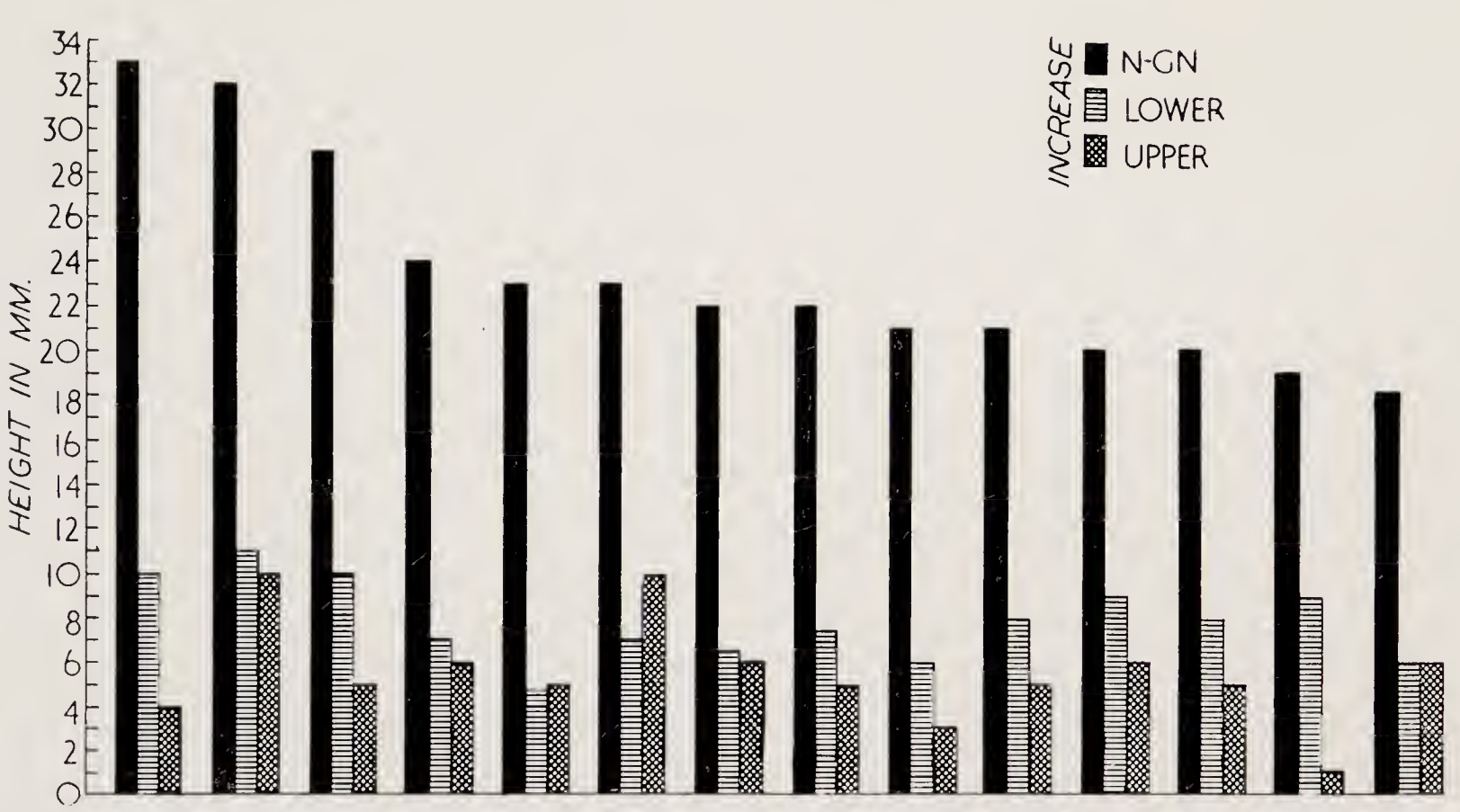


Fig. 6.—Diagram showing relative increase in anterior alveolar height, upper (V–Si) and lower (Z–Li), and total anterior height (N–Gn) in the male. Data arranged in order of decreasing magnitude of N–Gn show lack of correlation.

processes in the areas studied (*Figs.* 3–5).

Differences of Localization of Growth.—In both males and females the vertical increase in the lower anterior region was greater than that in the lower molar area: Female, lower

In the maxillary readings just the opposite was true, the molar height increase in both sexes being higher than the anterior increase: Female, anterosuperior 6·5 mm., posterosuperior 10·5 mm.; Male, anterosuperior

5·5 mm., posterosuperior 11·5 mm. (*Figs.* 10–14.)

This supports recent findings on the growth behaviour of the total pattern of the facial

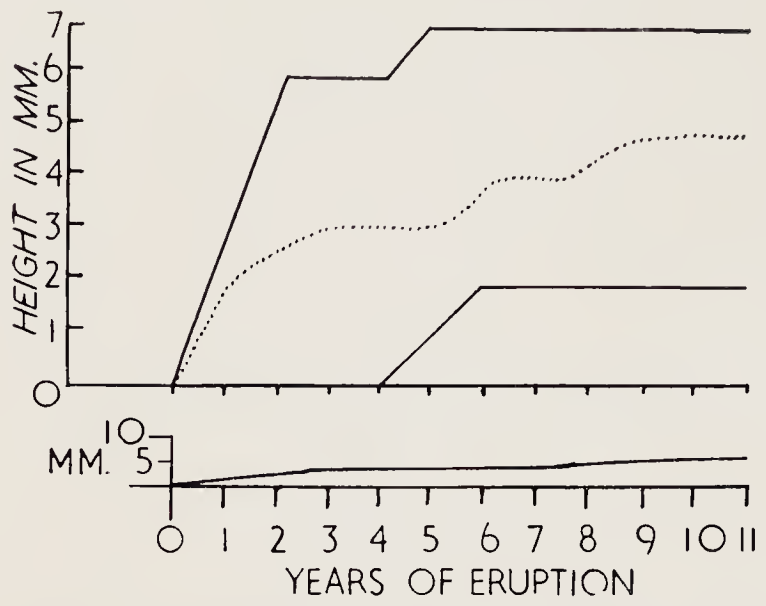


Fig. 7.—Graph of mean and total range of sample of growth in lower molar area (female). Low curve shows actual mean increment in mm.

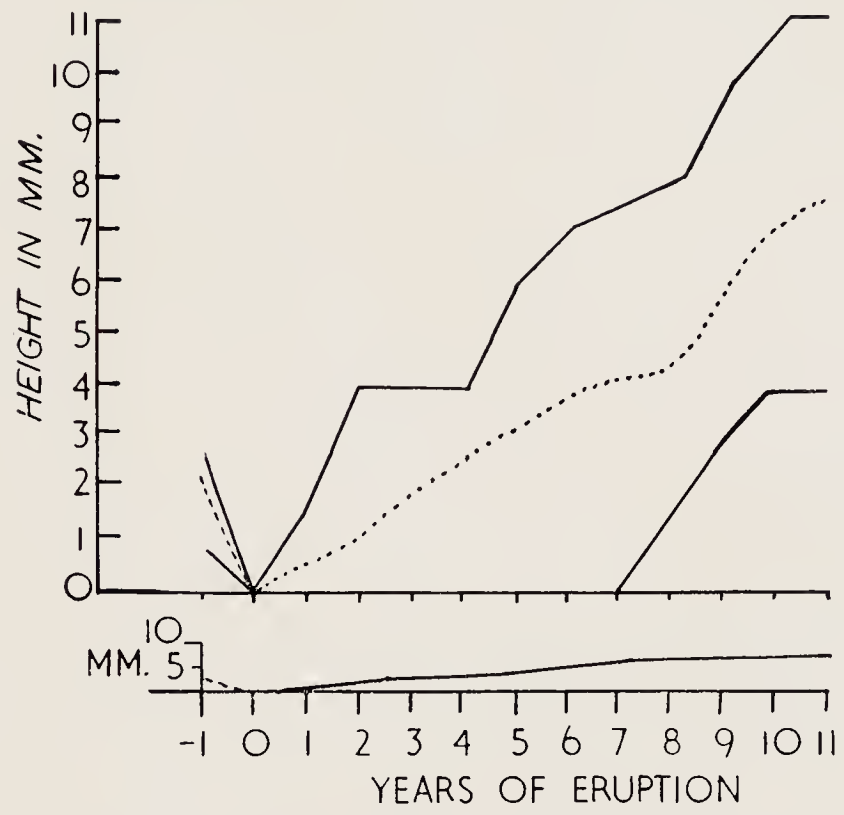


Fig. 9.—Graph of mean and total range of sample of growth in height of alveolar process in lower molar area (male). Low curve shows actual mean increment in mm.

growth (Brodie, 1948, a or b; Bjork, 1951) that the posterior end of the occlusal plane tends to drop with age.

Differences in Time.—Here again differences were found and they seemed to reflect sex differences as well as individual variation (*Table II*).

Variation in the time and order of eruption of the teeth has long been recognized, but we have been able to find no reference to any correlation that might exist between this phenomenon and the amount of alveolar growth. The present study indicated that teeth which erupt early were associated with

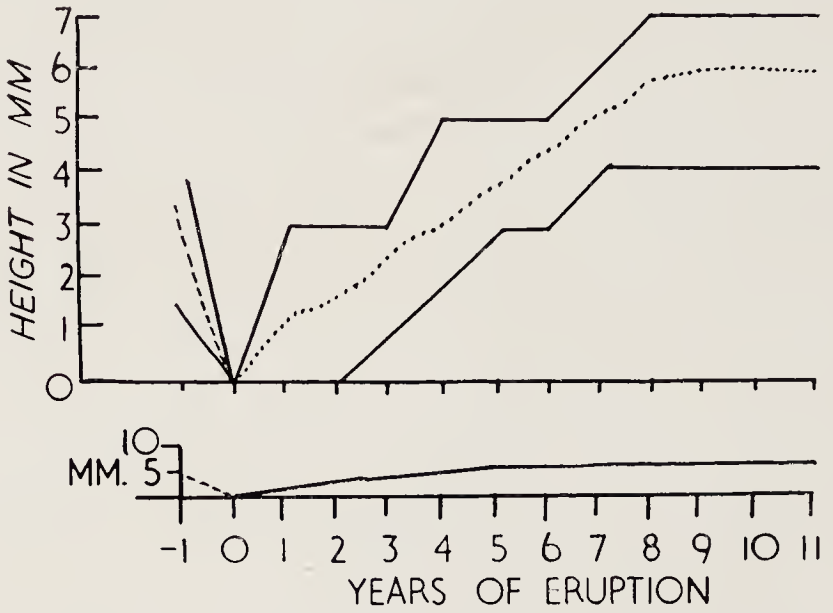


Fig. 8.—Graph of mean and total range of sample of growth in height of alveolar process in lower process in lower anterior area (female). Low curve shows actual mean increment in mm.

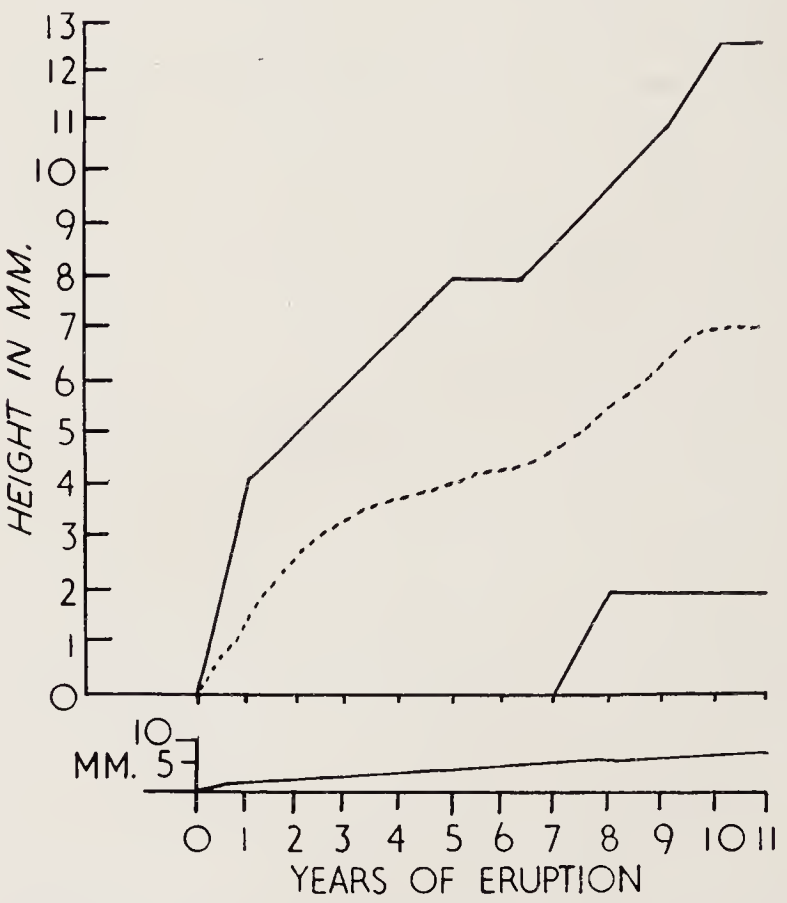


Fig. 10.—Graph of mean and total range of sample of growth in height of alveolar process in lower anterior area (male). Low curve shows actual mean increment in mm.

average or better growth of the process, while those erupting late showed slow and limited growth.

Discoveries of interest were made about the loss in height of the alveolar process at the time when the deciduous teeth were replaced by the permanent ones.

This phenomenon had already been remarked upon by research workers since John Hunter, but to my knowledge there had not been any measurement taken up till now.

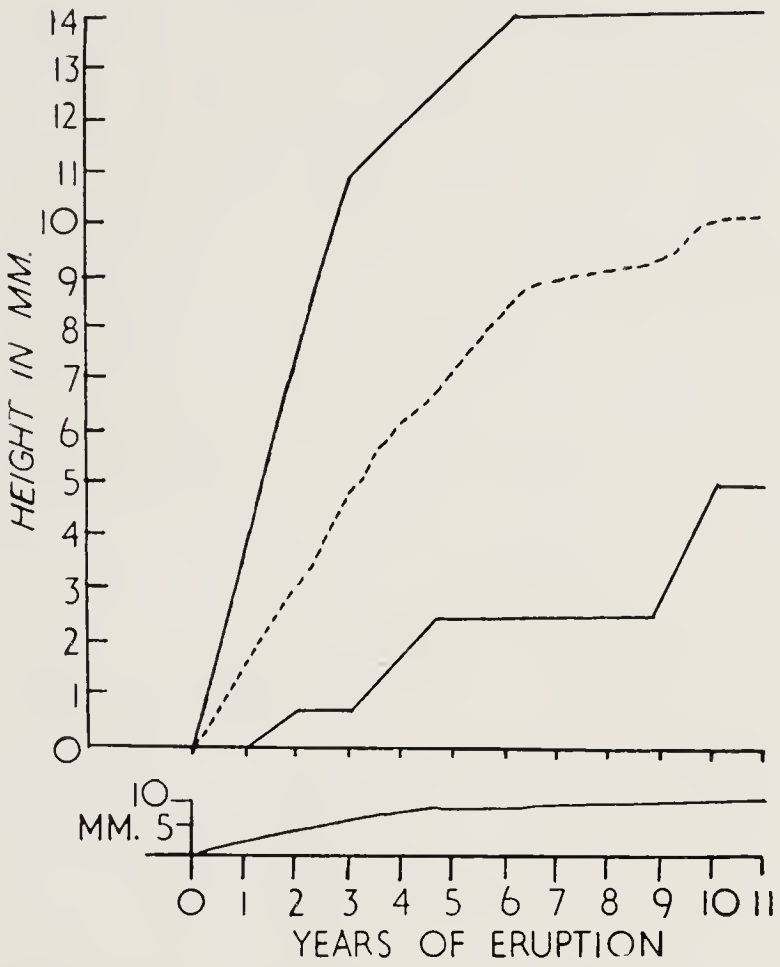


Fig. 11.—Graph of mean and total range of sample of growth in height of alveolar process in upper molar area (female). Low curve shows actual mean increment in mm.

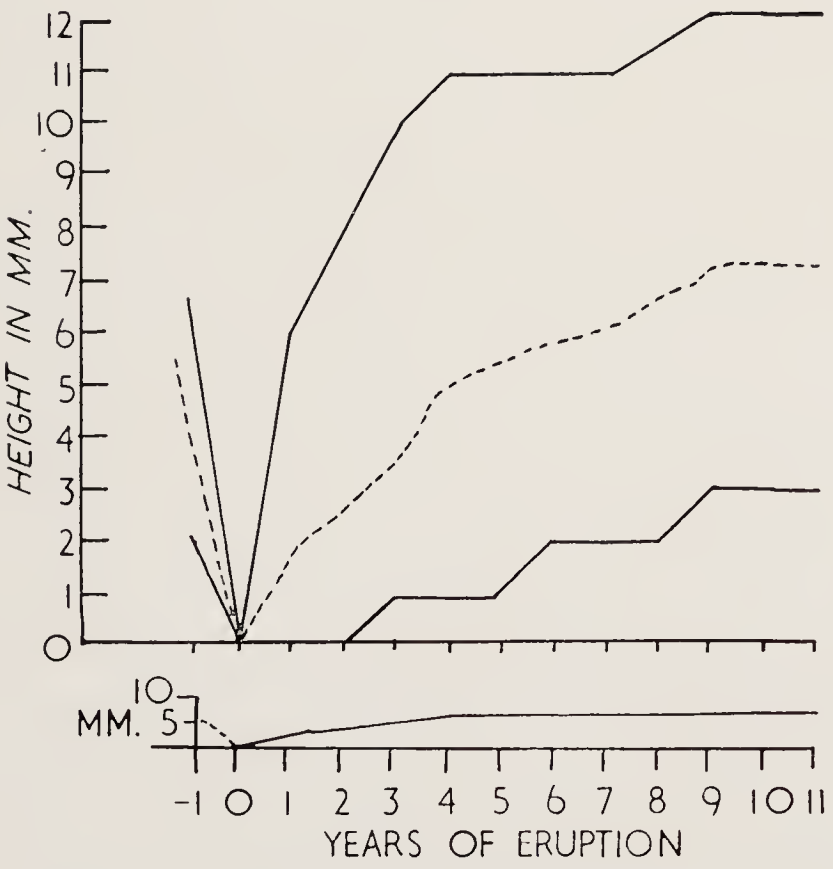


Fig. 12.—Graph of mean and total range of sample of growth in height of alveolar process in upper anterior area (female). Low curve shows actual mean increment in mm.

According to the obvious results given by radiographic examinations it is evident that the loss in height of the alveolar process coincided with the resorption of the root of

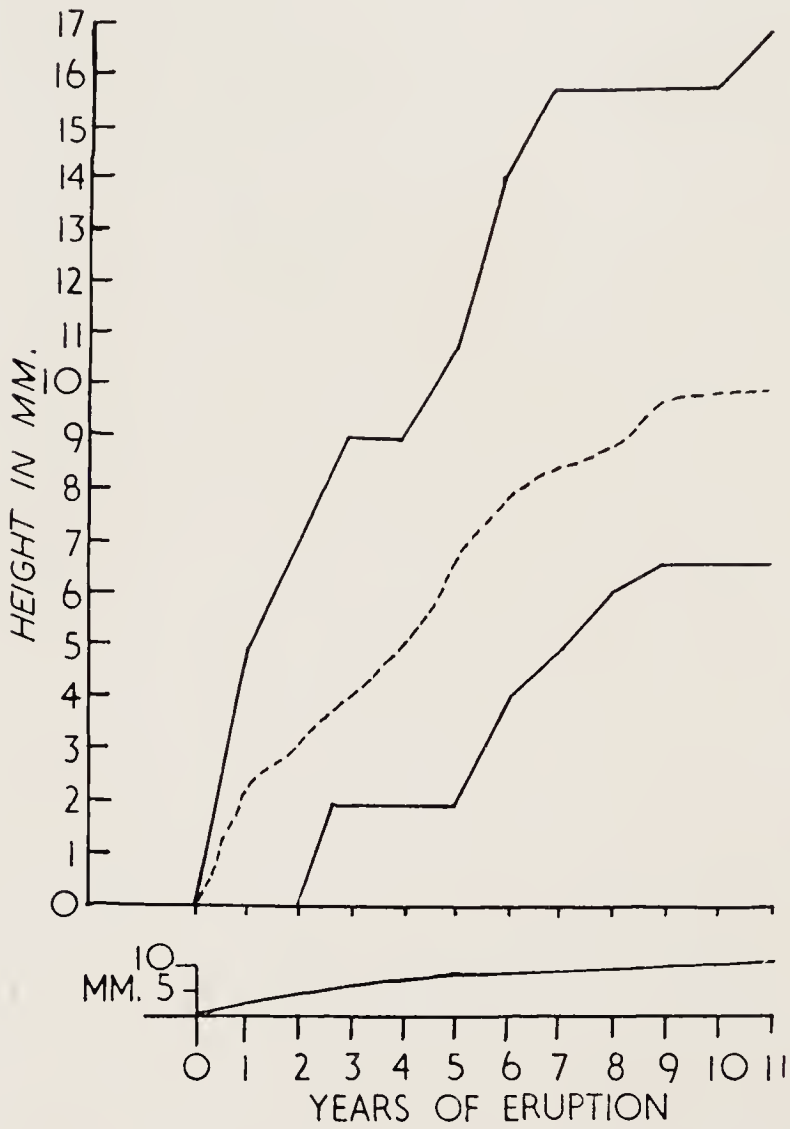


Fig. 13.—Graph of mean and total range of sample of growth in height of alveolar process in upper molar area (male). Low curve shows actual increment in mm.

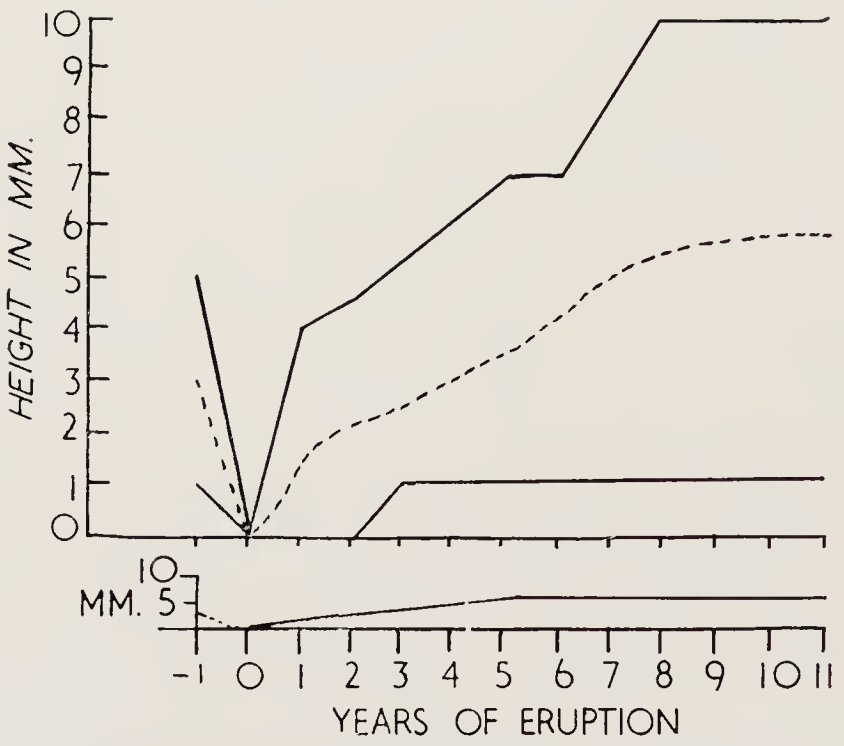


Fig. 14.—Graph of mean and total range of sample of growth in height of alveolar process in upper anterior area (male). Low curve shows actual increment in mm.

the deciduous tooth; the alveolar bone is attacked near its crest and portions may be cut off in the form of small sequestra (*Fig.* 15).

The loss in height thus sustained may be as much as 7 mm. This decrease is shown in *Figs.* 7, 9, 11, and 13, where the bottom of the curve represents the beginning of rebuilding of the process, regardless of age. The same curve shows that four or five years on the average is required to rebuild the process to its previous height. The process of destruction and rebuilding of the alveolar process probably occurs in the case of all of the succadaneous teeth. There would seem to be no need for it in the case of the molars and none was shown by measurements.

Table II.—Increase in Height of the Alveolar Process (Non-treated Cases)

Years of Eruption	MALE							
	Upper				Lower			
	Anterior		*Posterior*		*Anterior*		*Posterior*	
	No.	mm.	No.	mm.	No.	mm.	No.	mm.
— 2								
— 1	10	—3·1			2	—2·5		
+ 1	4	9·5	14	3·7	12	27	13	19·8
+ 2	11	13·5	14	6·5	14	26·6	13	22·5
+ 3	12	13·7	12	7·6	12	27·6	12	21·8
+ 4	14	13·8	13	7·6	14	28·1	14	22·1
+ 5	12	15	12	9	12	28·3	12	23·2
+ 6	14	15·7	14	9·7	14	29·2	14	23·2
+ 7	14	16·2	13	10·8	14	30·3	13	23·3
+ 8	13	13·8	12	12·4	10	30	11	26·2
+ 9	10	16·1	10	13·2	13	31·8	12	26·4
+10	8	16·6	8	13·7	8	32·2	9	25·3
+11	14	17·6	9	15·2	10	34·5	9	27·2
	FEMALE							
— 2	1	—2						
— 1	6	—5			4	—2·8		
+ 1	5	10·5	7	3·4	8	3·4	8	18
+ 2	9	11·6	9	5·1	9	27	9	19·3
+ 3	10	12·5	10	7·2	10	26	10	21·8
+ 4	10	13·2	10	8·5	10	26·9	10	20·2
+ 5	10	14·3	10	9·5	10	27·7	10	20·4
+ 6	8	14·4	8	10·8	8	25·1	8	20·6
+ 7	8	15	8	12·2	8	29	8	22·1
+ 8	10	15·1	10	11·3	10	29·5	10	21·3
+ 9	9	15·3	10	12·8	10	29·6	9	21·6
+10	8	15·2	8	13·1	8	29·3	8	22
+11	6	15	6	13·5	6	30·6	6	22·4

Differences noted in Treated Cases.—Included in the cases studied were 6 orthodontically treated cases, 4 males and 2 females. The same measurements were made on these that had been made on the untreated sample. Without exception all values were slightly higher than the means of the untreated cases, but the smallness of the sample made any conclusions dangerous (*Table III*).

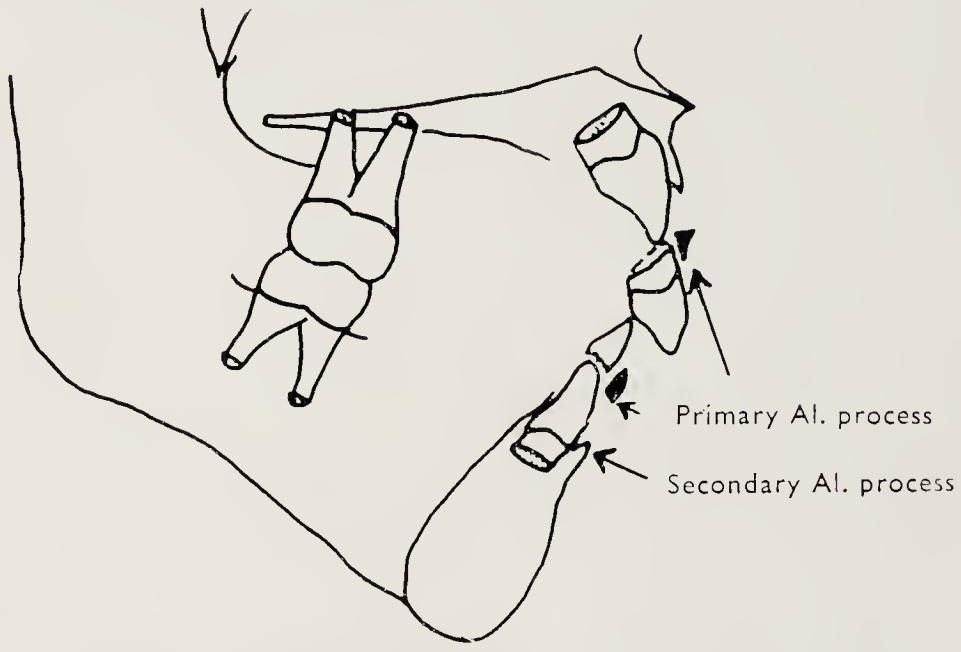


Fig. 15.—Male. Aged 6 years. Tracing of lateral X ray illustrating separation of primary alveolar process incident to eruption of permanent incisors.

Comparison of Treated and Untreated Cases.—In *Table IV* is shown a comparison of the mean increase in height of the alveolar process, with and without orthodontic treatment. The mean increase in the alveolar process during treatment was always slightly higher than in a normal case in all areas of the alveolar process.

The total dental height in the treated cases was greater than in the untreated cases, posteriorly and anteriorly. The total facial height in the male non-treated cases was always greater than in the treated cases. The reverse was true in the females (*Table V*).

Is this the influence of orthodontic treatment?

This is possible, but the small number of cases do not allow an affirmative conclusion to be expressed.

It is to this assembly of facts that I have given my name:—

1. Variations of growth in height;
2. Alveolar resorption;
3. Appearance of sequestra;
4. Rebuilding of alveolar process.

DISCUSSION

Although the phenomenon of tooth eruption has been studied by a variety of methods, it has been impossible to follow it quantitatively in the living individual until the advent of roentgenographic cephalometry. Even with this tool available it has been necessary to await the gathering of serial records over a period of years, the task undertaken by Broadbent under the auspices of the Bolton Foundation.

Table III.—Increase in Height of the Alveolar Process (Treated Cases)

Years of Eruption	Upper				Lower			
	Anterior		*Posterior*		*Anterior*		*Posterior*	
	No.	mm.	No.	mm.	No.	mm.	No.	mm.
— 1	5	—4·6			2	—5		
+ 1	6	10	6	5·4	6	26·1	6	19·3
+ 2	5	12·6	5	7·9	4	27	5	22
+ 3	5	14·3	5	8·8	5	27·7	5	23·2
+ 4	4	13·7	4	9·7	4	26·1	4	20·5
+ 5	5	13·7	5	10·2	5	27·1	5	20·6
+ 6	5	14·4	5	10·9	5	27·6	5	20·8
+ 7	6	15·5	6	13	6	29·5	6	22·5
+ 8	5	16·8	5	13·1	5	30·8	5	24·1
+ 9	5	16·3	5	14·6	5	31·8	5	24·6
+10	3	15·6	3	14·3	3	30	3	23·3
+11	2	20	2	16·5	2	37	2	29

Table IV.—Comparison of Mean Increase in Height of the Alveolar Process with and without Orthodontic Treatment (Average at 17 Years)

	Treated Cases	Male (non-treated)	Female (non-treated)
	mm.	mm.	mm.
Posterior lower	23·00	27·54	22·41
Anterior lower	37·00	34·81	30·83
Posterior upper	16·50	15·50	13·58
Anterior upper	20·00	18·34	15·00

It has been taught that the deciduous teeth, even after they were completely erupted, continued to be carried upward by the growth of the alveolar processes. This growth was thought to be interrupted for a short period by the loss of a small portion of their crests which took place coincidentally with the shedding of the deciduous teeth. Following the eruption of the permanent teeth the crest continued to grow.

The present research would seem to indicate that the process is not quite as it has been described. The alveolar process seems to begin to lose height well before the deciduous teeth

Table V.—Comparison of Total Dental Height and Total Facial Height (After Puberty)

	Treated Cases	Male (non-treated)	Female (non-treated)
	mm.	mm.	mm.
Posterior total dental height	60·50	58·26	50·60
Anterior total dental height	74·66	71·27	63·66
Anterior total facial height	125·00	128·07	117·40
Posterior total facial height	86·00	87·85	78·40

are lost. Also, it loses more than has been generally supposed and although it grows at its highest rate during the period of active eruption of the permanent successors it does not regain former height for several years.

If these conclusions are correct, it would mean that after the initial stage of eruption of the deciduous teeth there was a relatively long period during which there was little addition in height of the alveolar processes. During this time, however, the steady growth of the face continues with its accompanying descent of the mandible away from the maxilla. This would tend to increase the distance between upper and lower teeth when the mandible was at its position of rest. Unfortunately this could not be checked in the present study owing to the fact that all of the head X rays were taken with the teeth in occlusion.

Thought on continuous growth of the alveolar process has been unduly influenced by the investigations conducted with vital dyes on lower animals. These have invariably revealed heavy staining of the free margins of the alveolar processes which has been taken to indicate prolific growth. Instead of this, it probably denoted merely a rapid reconstruction process in response to the varied stresses

that fall upon this area. The superposing of successive tracings of the same mandible reveals clearly that the increase in height that takes place between the primary and secondary teeth is little greater than the height of the crowns of the permanent teeth in most cases (Brodie, 1948 a, b).

The differences noted in the present study of the variation in the amount of alveolar growth in different areas and particularly the greater increase of the upper over the lower posterior area, coincide with all of the recent findings on the growth behaviour of the facial skeleton. It has been found by several investigators that the posterior ends of the lower border of the mandible and of the occlusal plane tend to drop in the later stages of growth. Most of that work has been done on male samples and the increase shown by the female in the upper anterior region has not previously been pointed out. It would be interesting to determine whether this was correlated with a difference in behaviour of the mandibular lower border and the occlusal plane in the female.

The fact that the treated cases, as a general rule, yielded higher values has implications for the orthodontist. The question naturally arises as to whether malocclusion acts as an inhibiting force which treatment eliminates, or whether the mere stimulation of treatment acts as an accelerator. It has been shown that the wearing of intermaxillary elastics tends to reverse the characteristic behaviour of the occlusal plane. A much larger sample would need to be studied before safe conclusions on these matters could be arrived at.

The lack of correlation found between the increase in height of the alveolar process and that of the total face casts further doubt on the premise that the alveolar process is responsible for a significant amount of such growth.

SUMMARY

A study of the growth in height of the alveolar process in 30 individuals has been reported. The investigations covered the age range of 4–20 years by means of cephalometric X rays. Measurements were taken from the crest of the alveolar process in the maxilla at the incisor and first molar area to a plane connecting the anterior and posterior nasal spines; and in the mandible, from the crest of the process at the incisor and molar area to a line representing the lower border of that bone.

The measurements revealed scx differences as well as differences in location. The amount of increase in height and of time between treated and non-treated cases revealed some variations also.

Of great interest was the loss in height of the alveolar process during the shedding of the teeth.

The assembly of facts is the O'Meyer's sign.

REFERENCES

Bjork, A. (1951), *Dent. Rec.*, **71**, 197.

Black, G. V. (1902), *Descriptive Anatomy of the Human Teeth.* 4th ed. Philadelphia: S. S. White.

Brash, J. C. (1924), *Dental Board of the U.K.*, 21.

Broadbent, B. H. (1931), *Angle Orthodont.*, **1**, 35.

— — (1937), *Ibid.*, **7**, 209.

Brodie, A. G. (1934 a), The alveolar sutures in their relations to the growth of the jaws and the eruption of the teeth. Master's Thesis, University of Illinois.

— — (1934 b), *J. Amer. dent. Ass.*, **21**, 1830.

— — (1948 a), *Oral Surg.*, **1**, 334.

— — (1948 b), *Ibid.*, **1**, 342.

— — and Sarnat, B. G. (1942), *Amer. J. Dis. Child.*, **64**, 1046.

Hunter, J. (1771), *Natural History of the Human Teeth.* London: J. Johnson.

MacMillan, H. W. (1924 a), *Int. J. Orth.*, **10**, 375.

— — (1924 b), *J. Amer. Dent. Ass.*, **11**, 1059.

— — (1927), *Ibid.*, **14**, 697.

O'Meyer, R. X. (1948), XXI^{e} Congrès de la Société Française d'Orthopédie Dento-Faciale. Paris.

— — (1954), *Relative Growth Rates (Height) in the Alveolar Process in Man.* Paris: Maloine.

Orban, B. (1944), *Oral Histology and Embryology.* Saint-Louis: C. V. Mosby.

Ortiz, M. H., and Brodie, A. G. (1949), *Anat. Rec.*, **103**, 311.

Sicher, H., and Weinmann, J. P. (1947), *Bone and Bones.* Saint-Louis: C. V. Mosby.

DISCUSSION

Mr. J. H. Hovell, in opening the diseussion, thankcd Dr. Roger O'Meyer for coming to England to deliver the paper. Dr. O'Mcyer was one of the four Freneh members of the British Society, and as such he was doubly welcome.

The excellent review of the literaturc which Dr. O'Meycr had given, besides providing a basis from which his own work had proceeded, served to rcmind one of those observations of Hunter and Brash on the growth of the jaws. Those valuable observations upon the dependencc of the alveolar process on the tceth and also on the fact that normal growth of facial bones oecurred in thc absence of teeth were ignored or lost sight of for many years. As a result, much useless orthodontic treatment based upon entirely false premises was carried out. He had been most interested in hearing what Dr. O'Meyer had to say regarding the contribution of alveolar growth to facial height and thc lack of correlation between those, and also the changes in alveolar height occurring during thc change-over from the deciduous to the pcrmanent dentition.

He himself had never observed radiographically the separation of the deciduous alveolar crest in the form of sequestræ as describcd by the author, and if Dr. O'Meyer had with him any radiographs showing that occurrence, undoubtedly many members would like to see them at the end of the meeting.

It would also be interesting to know whether Dr. O'Meyer had made any further observations upon the possible increase of the inter-occlusal clearance during that period of development in which he had observed that alveolar growth was of minimal degree. Also in those treated cases in whieh alveolar growth was increased, what was the treatment and was there, subsequent to the conclusion of the treatment, a reversed trend? In other words, after completion of treatment did alveolar growth slow down beyond normal to give a final alveolar height the same as would have occurred without treatment, or was the increase in growth maintained?

It was a difficult paper to discuss because it was very mueh a faetual paper and one which gave the results of original cephalometric work, but in eonelusion he wished to congratulate Dr. O'Meyer upon a valuable contribution to the cephalometric study of facial growth.

Professor G. E. M. Hallett said he had had the pleasure of reading the paper in Freneh and so had had, as it were, a preview, and he wished to congratulate Dr. O'Meyer on the way in which he had delivered it and on the careful observations which he had made.

Like Mr. Hovell, he had been most interested in the phenomenon of the sequestration of the alveolar crest, and hc would like to have the privilege of seeing any radiographs that might be available. He wondered whether, amongst the radiographs which the author had traced, therc had been any examples of what were sometimes described as "submerged molars", from which it might have been possible to make some relative measurements in terms of dental height. It was known that the phenomenon appeared usually two to three years beforc normal cxfoliation, but there was not always the "submcrgence". For example, somctimes when the upper maxillary deeiduous incisors were retained for somc reason, thc gingival line appeared usually to continue normally with that of the permanent lateral ineisors which had already erupted.

Another point often occurred to him when people talked about tracing latcral skull radiographs, and that was the tcndcncy to assume that thc X rays were parallel and coming from an almost infinite souree. This was not so in dental radiography because thcre was only a matter of 5 ft. or 6 ft. (and he bclieved Dr. O'Meyer was working on Broadbent's radiographs, in which casc he was working on the lesser distance of 5 ft.). The cone of rays spread from the source to the objcet, which was itself at some distance from the film, and there was a very definite divergent eone of rays by the time it reached the tecth, and the molars themselves were some distanee from that central ray. The incisors were still farther away. It was a matter of fairly simple geometry (often forgotten) to show that the enlargement of the skull for a distance of 5 ft. was something of the order of $\frac{1}{2}$ in. The enlargement, therefore, of the molars would be quite definite when discussing apparent movements of $1\frac{1}{2}$ mm. Moreover, of course, the molar nearest the film would cause a different sized shadow from that of the other side. Then again a correetion should be applied before interpreting this phenomenon. It should also be done when assessing the relative drop in oeelusal plane level, and he wondered whether the author had done so in order to correct for this projection error.

Mr. W. J. Tulley said he had first been introduced to the work of Dr. O'Meyer by Dr. Brodie when he was in Chicago, and he, too, had been intrigued with the loss of alveolar process with the shedding of the deciduous teeth, and in fact the sequestration. He had not seen this in radiographs, and would very mueh like to do so. He wondered what state the deciduous incisors were in prior to their loss; were they, in fact, infected in some of those cases?

The President agreed with Mr. Hovell that it was a factual paper and therefore difficult to discuss, and said what he personally would like to do would be to go away and try to relate the laek of correlation pointed out by Dr. O'Meyer with the other ehanges that were seen during growth in the total morphology of the face.

He would like to suggest to Dr. O'Meyer that there was possibly a third explanation as to why there were the differences between the treated and the untreated cases. The author had said it was a small sample, and there was a possibility that in fact the treated cases were not a comparable sample at all, and that if they had not been treated they would have shown the same differenees, the difference being a greater increase in alveolar height. In his view, that was a distinct possibility, and looking at the morphology it might have been observed.

Dr. R. O'Meyer, replying to the diseussion, thanked Mr. Hovell for his appreciation of thc work and also for his help in interpretation.

With regard to the lack of correlation bctween the alveolar growth in height and the total faeial height, that might well form the subject of new researeh. It had taken him one and a half years to earry out his work, and although during that time he had seen many other radiographs, he had not had the opportunity of investigating which part was alveolar growth, which part was dental eruption, and which was facial growth, and undoubtcdly somc new research would bc necessary in order to find out.

Unfortunately he was unable to show radiographs of the sequestration of the deciduous alveolar process because when he studied that phenomenon he had used cephalometric X rays from the Bolton Foundation in Cleveland, and naturally he had not been allowed to borrow them, although he had with him some tracings from the originals. In cases where he had seen small sequestræ they always disappeared after about the age of 6 years. That might not always be so, but if serial X rays were taken of children up to 5 or 6 years it would probably be observed, and an investigation in a clinic or a hospital in this country might reveal the same thing as he had seen in Cleveland.

With regard to the question raised by Mr. Hovell as to the possible increase of the inter-occlusal clearance during the period of development in which alveolar growth was of minimal degree, it should be possible to find such an increase, but he had not actually taken any measurements of that. His own view was that when the alveolar growth was of minimal degree some other part of the facial growth was going up and at the same time the teeth also were going up, so it was extremely difficult to ascertain exactly the response of each part. His study had consisted of 30 series of lateral X rays, 12 being females and 18 males, of whom 6 were orthodontic patients. Most of the treatment cases were Class II, division 1, and they were treated with a Class II elastic, he believed with the edgewise technique. It was well known that the wearing of intermaxillary elastic tended to reverse the behaviour of the occlusal plane. It was also known from findings on the behaviour of facial growth that the posterior end of the occlusal plane tended to drop with age. He had studied patients from 4 to 20 years of age and had not observed that alveolar growth slowed down after treatment.

As regards the point raised by Professor Hallett he certainly took great care with the radiographs, first between the left and right molars and also between them and the anterior teeth, and when he found a deciduous molar he did not use the alveolar process in the measurable part.

In answer to Mr. Tulley, he was unable to say whether the sequestration was pathological or physiological. He used Dr. Broadbent's radiograph, and although he was provided with some detail as to the orthodontic treatment given, he was supplied only with a number and with no personal details of the patient.

Concluding his reply, Dr. O'Meyer asked members to excuse his accent; he had some good English friends who always laughed at him because of his French American English accent.

Proposing a vote of thanks to Dr. O'Meyer, *The Chairman* said that to the best of his knowledge it was the first occasion on which the Society had been addressed by a doctor from France, and he hoped it would not be the last. During the last few years there had been an increasing association between the English and French orthodontists which would undoubtedly lead to a better understanding all round. On the whole the French tended to be a little more philosophical in their approach to the subject, and British orthodontists could gain from that.

The vote of thanks was accorded with acclamation and the meeting then terminated.

AN INVESTIGATION INTO THE EFFECTS OF PRESSURE ON VARIOUS BONY SITES IN THE RABBIT

By **C. M. PERSTON**, M.D.S. (Belfast), D.Orth. R.C.S.

Aim.—To explore the possibility of using mechanical forces, which are capable of modifying the form of alveolar bone, to modify the form of non-alveolar bone.

A review of the extensive relevant literature was not possible in the time available.

Appliances were designed to exert constant pressure on four bony sites in the rabbit for periods varying from 2 to 10 weeks; 51 experiments were completed. On recovery the material was sectioned and examined microscopically. In all, except the first series, the appliances were inserted under the skin.

First Series.—A pressure of 30 or 60 g. was exerted on the dorsal, medial, or lateral surfaces of the proximal phalanx of the toes of adult animals for 14 or 28 days, through the skin; 18 experiments were completed.

Sandal-like appliances were made in acrylic resin and attached to the feet of the animals. Springs fitted into tubes embedded in the resin. Where a spring contacted the skin the metal was covered in polythene tubing.

When a pressure of 60 g. was effective for 4 weeks on the dorsal surface of a phalanx small areas of resorption were observed, in the bone, deep to the source of pressure. On the medial and lateral surfaces large bony masses proliferated.

When a pressure of 30 g. was exerted on the medial or lateral surfaces of a phalanx the results were variable. In some cases small areas of resorption were seen deep to the source of pressure, while in others large masses of bone and cartilage had developed.

Second Series.—A pressure of 50 g. was exerted on the suture between the nasal bones in 3- and 6-month-old rabbits for 2 or 4 weeks. Hooks on each appliance fitted into grooves cut in the nasal bones superficial to the position of the conchæ on each side and so attachment was gained without penetrating into the nasal cavity. Nine such appliances were inserted.

On microscopical examination, in most cases, parts of the anterior half of the suture were acellular. Osteoclasts were present in the marrow spaces and in the suture adjacent to the cell-free regions.

In no completed experiment was there a measurable difference in the distance between the hooks at the beginning and at the end of the experiment.

Third Series.—Pressure was exerted across the epiphysial cartilage of the second metatarsus in 14 animals. The animals were 10, 15, or 16 weeks old at the start of the experiments, which lasted for 4 to 10 weeks. The appliances exerted a pressure of 50 g. when inserted. In the 10-week-old animals the growth of the cartilage further separated the legs of the appliance to the extent that in one case the cartilage bore a load of 900 g./sq. cm. of surface area. In most cases the bone in which the appliance was inserted was shorter than its corresponding bone in the other foot, but no significant change in the trabecular bone in the diaphysis could be demonstrated.

Fourth Series.—Pressure was applied to the periosteum of the anteromedial surface of the tibiæ, of 6-month-old animals, slightly distal to the proximal epiphysial cartilage. A pressure of 60 or 160 g. was applied for 4 or 10 weeks. Ten experiments were completed.

After 4 weeks the bone deep to the plate exerting pressure appeared thinner than that of the cortex, at a corresponding level, of the tibia of the other leg. Round the sides of the plate deposition of bone was taking place.

After 10 weeks the plates were completely surrounded by bone.

A demonstration at the meeting held on May 13, 1957.

CONCLUSIONS

In general the results of this investigation do not support the hypothesis that mechanical appliances could be used clinically to modify, by pressure, the form of the non-alveolar bone of the jaws in the later stages of growth.

Where resorption of bone occurred as a result of applying pressure the resulting change in form was very small.

Where it could be recognized that deposition of bone resulted from the application of pressure the factors determining the form and distribution of the new bony masses could not be positively identified.

I am indebted to Mr. H. T. A. MeKeag, on whose suggestion I undertook this investigation, for advice and criticism; to Professor J. J. Prichard for his permission to use the facilities of the Department of Anatomy, Queen's University, Belfast, and for advice and criticism; and to Dr. J. H. Scott for advice.

THE ERUPTION OF THIRD MOLARS FOLLOWING EXTRACTION OF SECOND MOLARS

By **D. I. SMITH**, F.D.S., D.Orth. R.C.S.

A GROUP of 113 orthodontic patients was invcstigated. In each case one or more second molars had bcen extracted during orthodontic

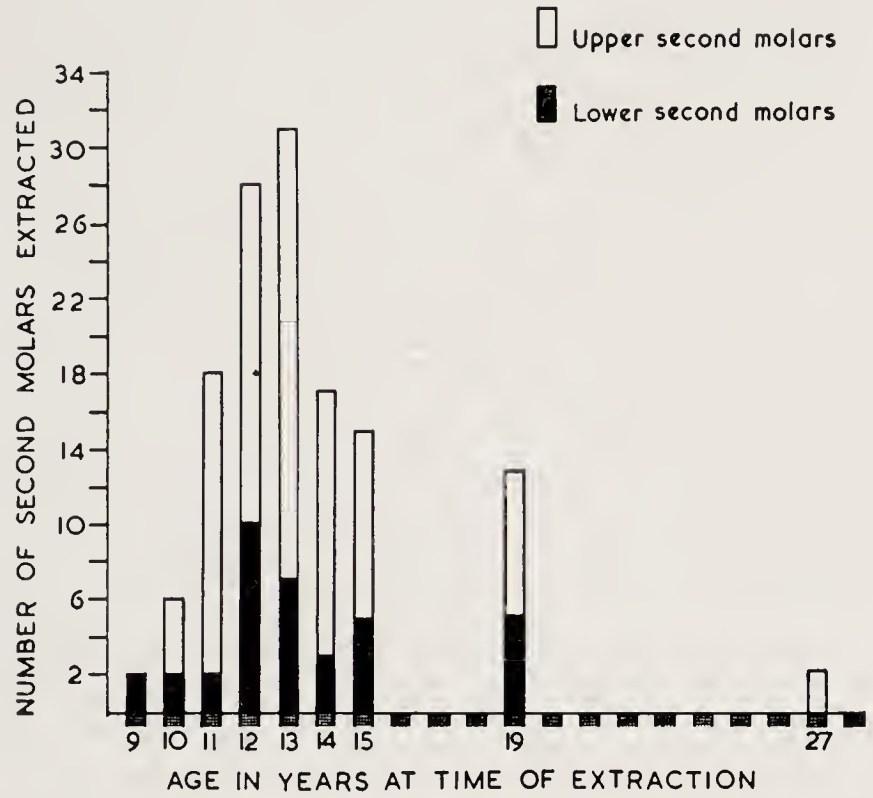


Fig. 1.—Showing age distribution of second molar extraction.

treatment. Inadequate records led to the elimination of 45 cases and in a further 16 eruption is still taking place.

Complete eruption of 94 upper third molars and 34 lower third molars was observed. Age at the time of extraction varied between 9 years and 27 years. *Fig.* 1 illustrates the age distribution.

The third molars were examined clinically and radiographically with special reference to: (1) Occlusion with opposing teeth; (2) Presence of contact point mesially; (3) Axial inclination.

The lower third molars were compared with a standard (*see* $\overline{|8}$ in *Fig.* 2 B). A lower third molar with an equal or lesser degree of tilt was classified as having an acceptable axial inclination.

RESULTS

Upper Third Molars

Total	In Occlusion with Opposing Tooth	Mesial Contact Point	Acceptable Axial Inclination
94	94	90	91

Three upper third molars were in buccal relationship to the lower arch.

Loss of four upper first molars accounted for absence of contact points and tilt of the neighbouring upper third molars.

Lower Third Molars

Total	In Occlusion with Opposing Tooth	Mesial Contact Point	Acceptable Axial Inclination
34	33	20	17

Three relevant lower first molars were lost owing to caries in this group.

In this small series there was no apparent correlation between age at the time of extraction of lower second molars and the final occlusion of lower third molars. The axial inclination of the developing lower third molars bore no obvious relationship to their eventual position.

CONCLUSION

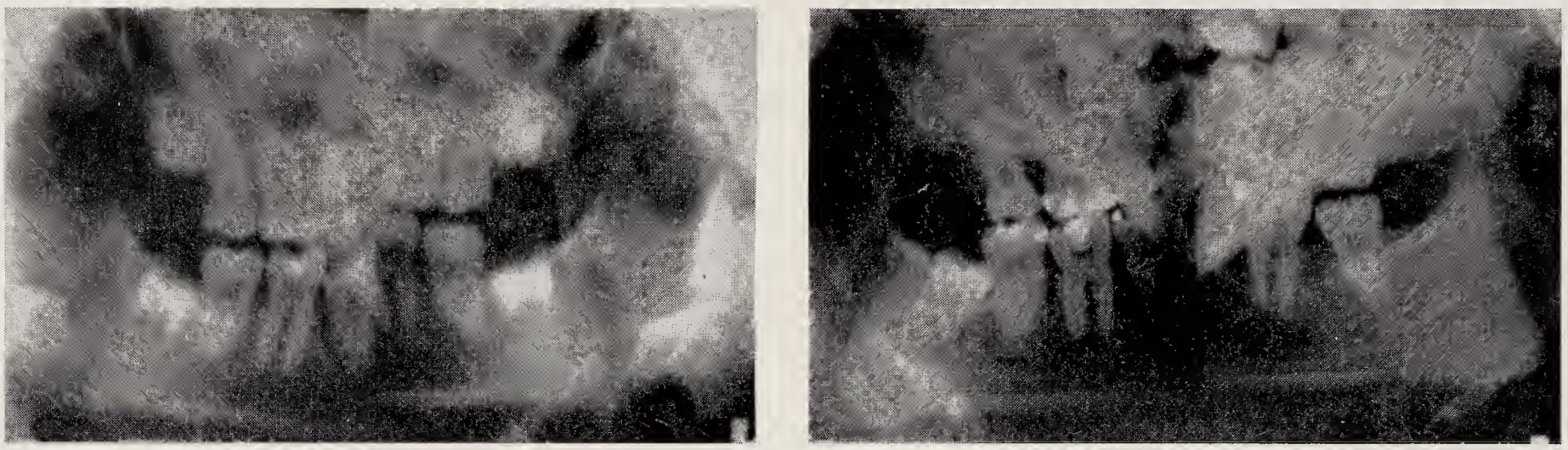
In the cases investigated the upper third molars erupted, almost without exception, into good position. The lower third molars exhibited a wider range of final position (*Figs.* 3–8). The majority erupted into occlusion, but were tilted in varying degrees.

DISCUSSION

There are several purely local factors to be considered before deciding to extract second

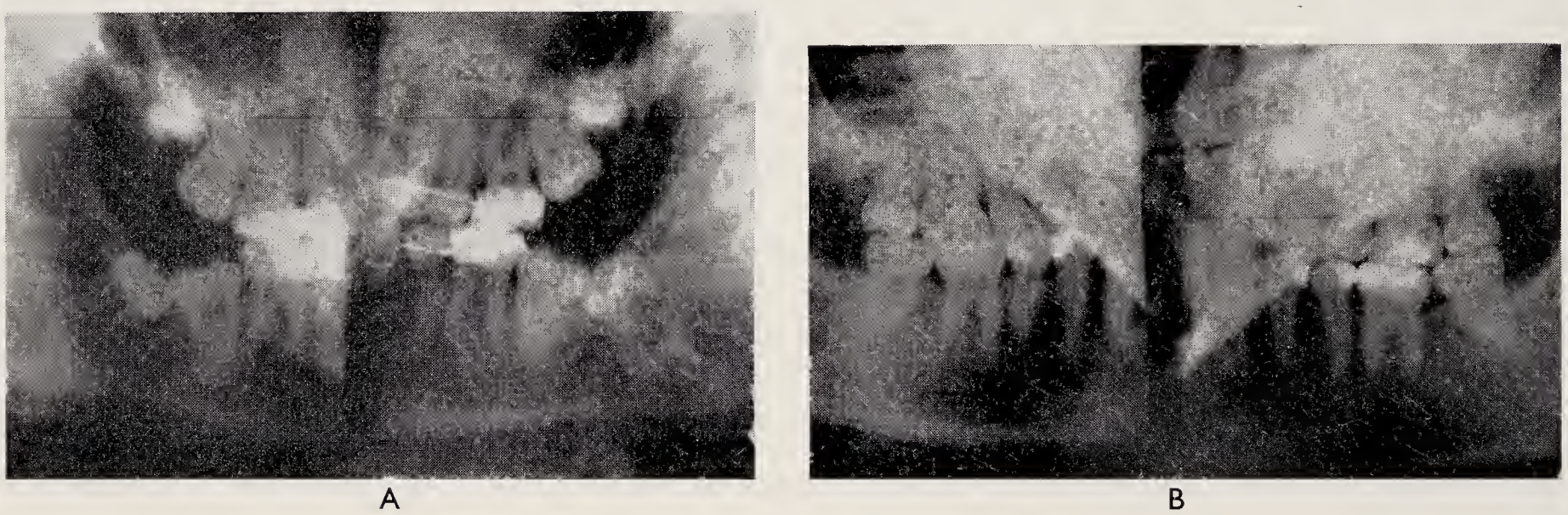
A demonstration at the mecting held on May 13, 1957.

molars as part of orthodontic treatment:—There may be loss due to caries of first molars in the buccal segments from which second molars were removed. This occurred in 7 instances in the group investigated.



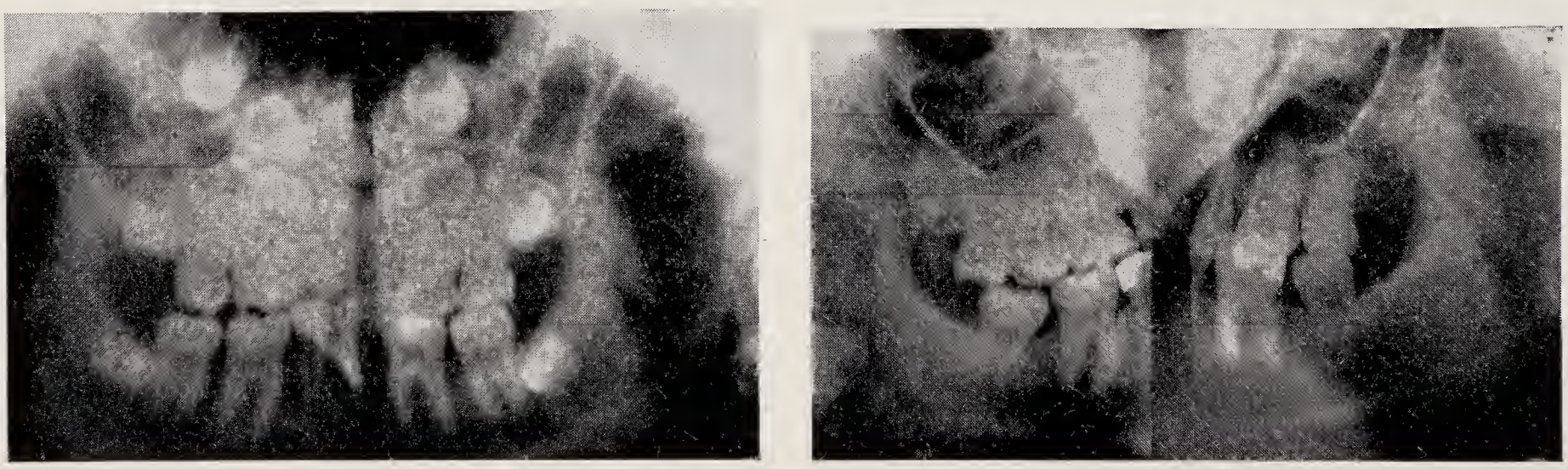
A B

Fig. 2.—*Case* 12. A, Right and left lateral oblique radiographs at age 12. The $\frac{|7}{7|}$ were extracted at age 13 years 2 months and $\underline{7|}$ at age 14 years 11 months. B, Right and left lateral oblique radiographs at age 17 following eruption of $\frac{8|8}{|8}$ at 17 years. The $\overline{|8}$ in this case was used as standard for the assessment of axial inelination. The failure to remove $\overline{7|}$ has provided a control in this case.



A B

Fig. 3.—*Case* 58. A, Right and left lateral oblique radiographs at 16 years. The $\frac{7|7}{7|7}$ were extracted at age 19 years 4 months. B, Right and left lateral oblique radiographs at 21 years following eruption of $\frac{8|8}{8|8}$ at 21 years. This represents the most favourable result in this series.



A B

Fig. 4.—*Case* 4. A, Right and left lateral oblique radiographs at 13 years, prior to extraetion of $\underline{|7}$ at 13 years and $\overline{7|7}$ at 15 years. B, Right and left lateral oblique radiographs at 17 years following eruption of $\frac{8|8}{8|8}$ at 17 years. Note tilting of $\overline{8|8}$ and absence of mesial contact points.

Fig. 5.—Radiographs taken: A, At 14 years of age, 1 year before removal of $\frac{7|7}{7|7}$; B, Two years after extraction.

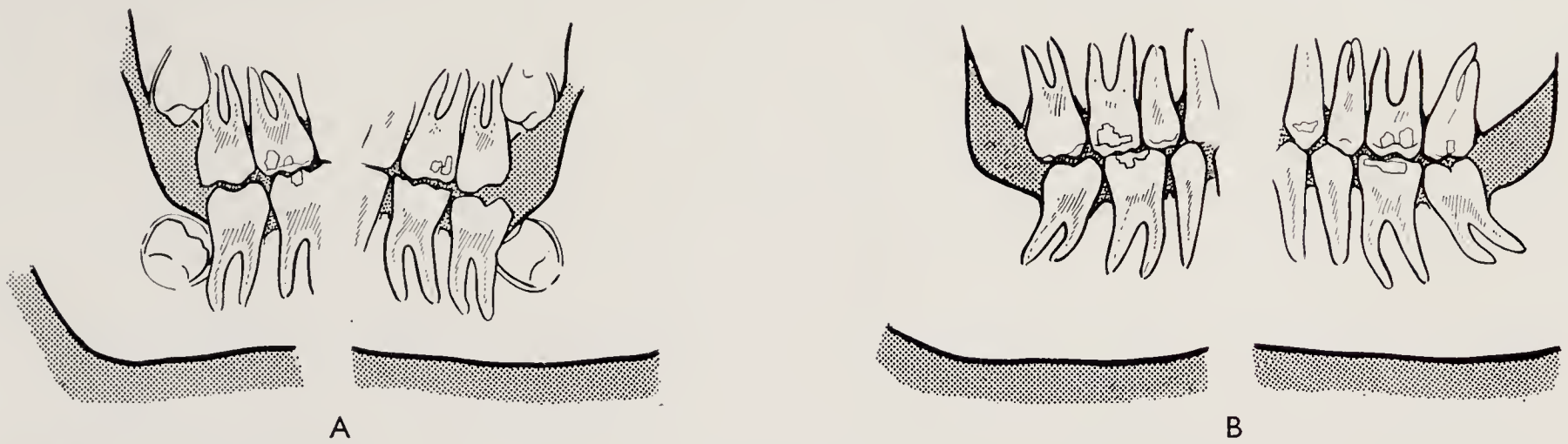


Fig. 6.—Radiographs taken: A, At 11 years of age, 1 year before extraction of second molars; B, At 17 years of age.

Fig. 7.—Radiographs taken: A, At 12 years of age, 1 year before extraction of second molars; B, At 18 years of age.

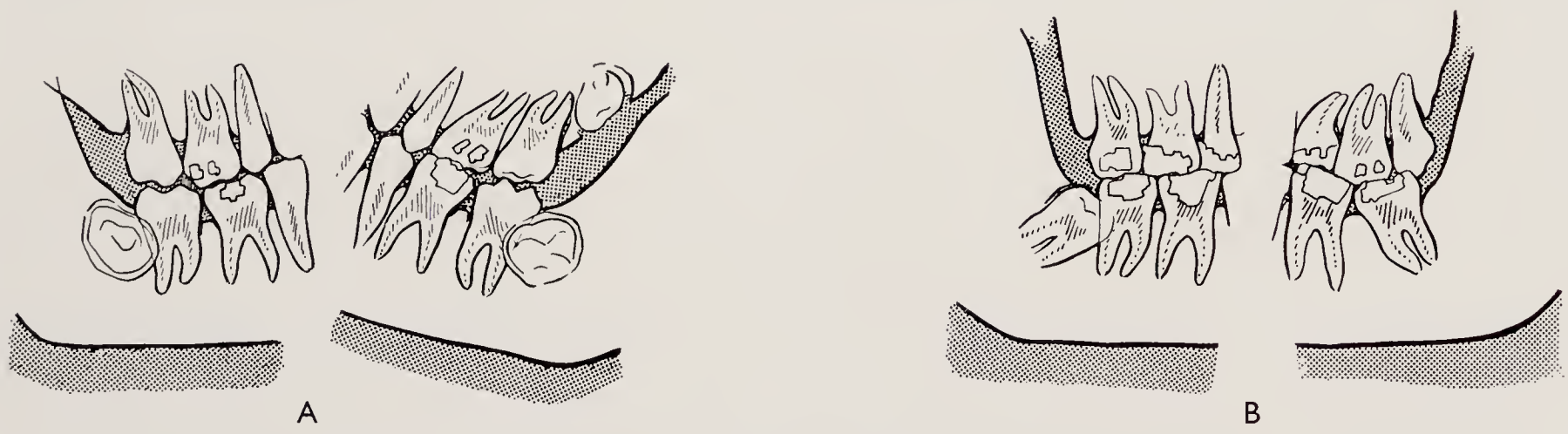


Fig. 8.—Radiographs taken: A, At 13 years of age, 2 years before extraction of second molars; B, At 19 years of age.

The third molar is frequently smaller than the second molar it is to replace, so that the eventual size of the tooth must be considered.

In the lower arch tilting and absence of contact point may be expected, but complications such as "pericoronitis" and the need for surgical removal are avoided.

A MOBILE ORTHODONTIC CHAIRSIDE DESK

By **F. D. ROWE**, L.D.S. Presented by **J. W. SOFTLEY**

THE operative procedures involved in orthodontic treatment lend themselves well to working in a seated position.

The desk (*Fig.* 1) has been designed to save time and effort and to facilitate carrying out treatment whilst seated.

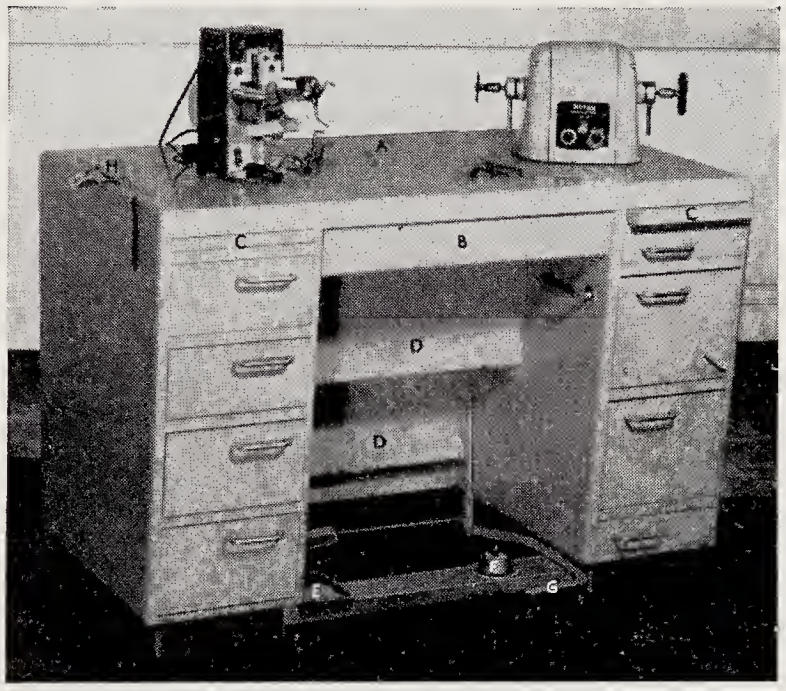


Fig. 1.—A, Flap concealing wire-dispenser chamber, elevated by foot-pedal G; B, Waste drawer; C, Extending leaves; D, Boxes housing spools of chrome alloy strip and wire; E, Foot-pedal for welder; F, Foot control for grinding lathe; G, Foot-pedal for flap covering dispenser chamber; H, Holder for impressions in trays.

The desired characteristics have been achieved by means of the following features:—

1. Mobility.—

a. The desk can easily be moved into whatever position is most convenient for the job in hand. It is mounted on "Shepherd" easy-running, spherical castors.

b. Enables welder, grinding lathe, etc., to be placed close to the patient, so eliminating time-wasting movements and needless expenditure of effort in constructing and fitting appliances.

c. Extending leaves (Formica-covered) can be conveniently placed for writing, as when carrying out diagnosis, filling in records, etc.

d. Since it is designed for operating in a seated position, efficiency in working can be greatly improved if used in conjunction with a mobile stool (e.g., Sterling).

2. Storage.—Almost everything required for treatment (excluding the sterilizer) can be arranged to be within arm's length when seated. At the same time these are concealed from the patient's view until needed. The following items can be accommodated, still

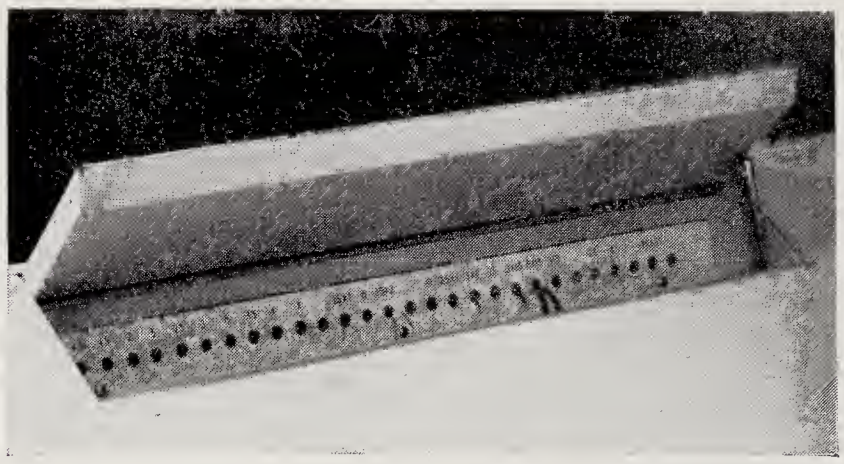


Fig. 2.—Flap covering dispenser chamber, in elevated position.

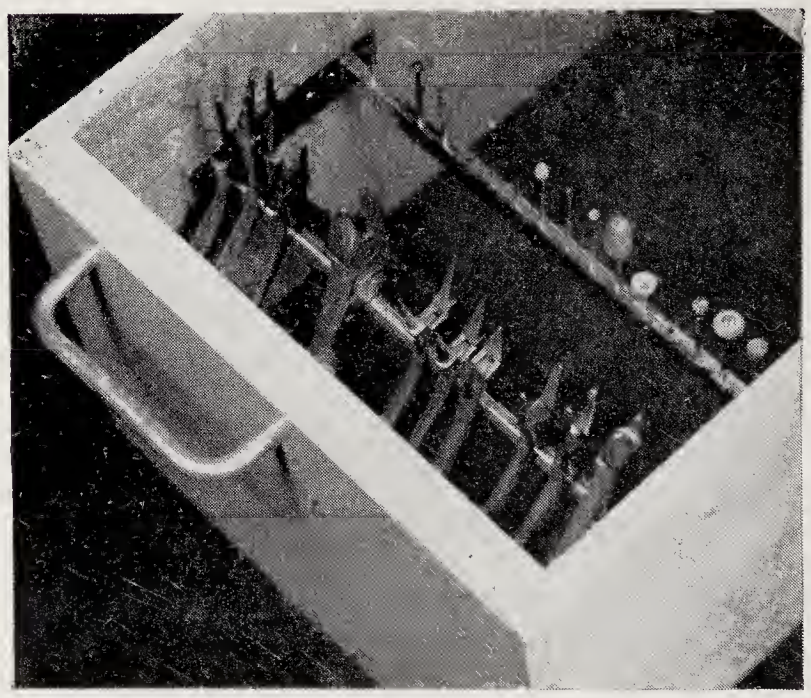


Fig. 3.—Drawer containing plier rail and bur and stone rack.

leaving further available drawer space for personal requirements:—

a. Chrome alloy strip and wire, which are housed in two built-in boxes at the rear of the central knee-hole and enter a chamber immediately under the bench top. When the material is required, a flap covering the chamber (*Fig.* 2) is lifted by pressure on a conveniently placed foot-pedal. The dispenser will accommodate 28 varieties of material

A demonstration at the meeting held on May 13, 1957.

wound on two sizes of spool, supplied by Temco Ltd. There is a removable panel in the back of the bench which is taken out to give access for loading spools into the dispenser (*see Fig.* 2).

b. Pliers, burs, and stones (*Fig.* 3), mouth instruments, impression trays (*Fig.* 4), mixing bowls, mixers, measured impression material, cements, glass slabs, cotton-wool holder, cotton rolls, waste receiver, wax, X-ray film, X-ray cassettes, plastic containers for appliance

Fig. 4.—Drawer containing impression trays,

components, etc., chrome alloy tubing, oral hygiene leaflets, rubber bands, etc.

c. A wide, centrally placed waste drawer makes it easy to keep the desk-top tidy by providing a receptacle for wire and strip cuttings, powdered acrylic resin from trimming of plates, etc.

d. The wooden stand illustrated in *Fig.* 5 fits in one of the drawers and holds six measures of hydrocolloid impression material and two measures for water. Lids turned out of Perspex fit the powder measures, so avoiding any ill-effects from exposure of the contents to the air. The stand fits in one of the desk drawers, and is removed for refilling the measures. The stock of ready measured powder reduces delays when impressions are

Fig. 5.—Stand for measured hydrocolloid impression material.

required and time is saved by refilling six measures at once.

3. Construction and Finish.—

a. Dimensions: height, 2 ft. 8 in.; width, 3 ft. 9 in.; depth, 2 ft.; knee-hole, 1 ft. 10 in. wide; drawers (8), 10 in. wide.

b. Formica easy-clean top.

c. Sound-deadening material underneath Formica top to reduce noise of placing pliers thereon.

d. Smoothly rounded corners.

e. Light enamel finish.

Acknowledgements are due to Mr. C. P. Adams, B.D.S., F.D.S., D.Orth., for details of wire-dispenser design, and to Mr. E. W. Rigby, the cabinet-maker who has constructed the desk and to whom I am indebted for many helpful suggestions.

THE TREATMENT OF ANGLE'S CLASS II, DIVISION 1 AND CLASS II, DIVISION 2 IN IDENTICAL TWINS

By **H. L. LEECH**, B.D.S., F.D.S., D.Orth.

In February, 1955, I read a short paper to this Society in which I described the skeletal and soft-tissue morphology and behaviour of these interesting twins, one with a typical Angle's Class II, division 1 malocclusion and the other with a typical Class II, division 2 malocclusion (*Figs.* 1, 2). It was seen that the main difference between them was the position of the upper central incisors, the proclination in the former and retroclination in the latter being attributed to their respective relationships to the soft tissues, especially the lower lip.

Fig. 1.—Photographs and tracings of Cecily (div. 1) and Margaret (div. 2, with teeth slightly open). Note the relationships of $\underline{1|1}$ to the lower lip.

Both twins had slightly incompetent lips and contracted them on swallowing, the twin with the Class II, division 1 malocclusion with the lower lip contracting behind the upper incisors and with an associated slight tongue thrust. The other with the Class II, division 2 malocclusion had the lower lip contracting over the upper incisors forcing the centrals back to the post-normal lower arch. In neither case was there a history of thumb-sucking.

The orthodontic treatment was very similar in each twin in order to achieve as near an

Given at the meeting held on October 14, 1957.

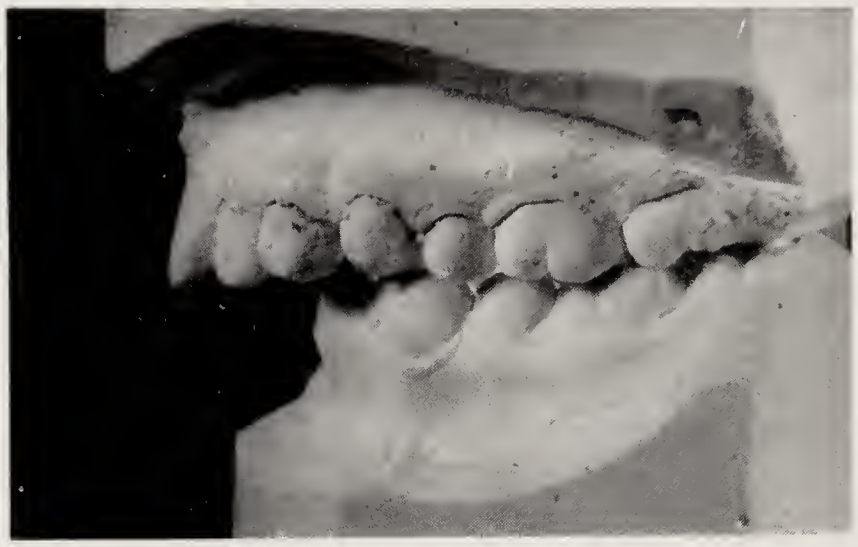


Fig. 2.—A, Models showing the malocclusion in the case of Cecily; B, *See* page 62.

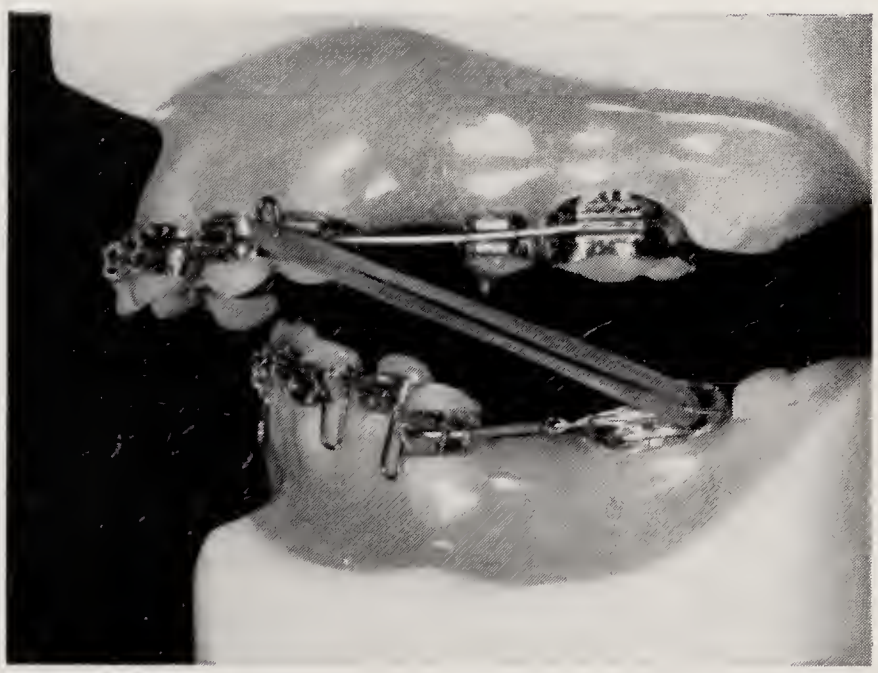


Fig. 3.—A, Showing the appliances used in the case of Cecily (div. 1); B, *See* page 62.

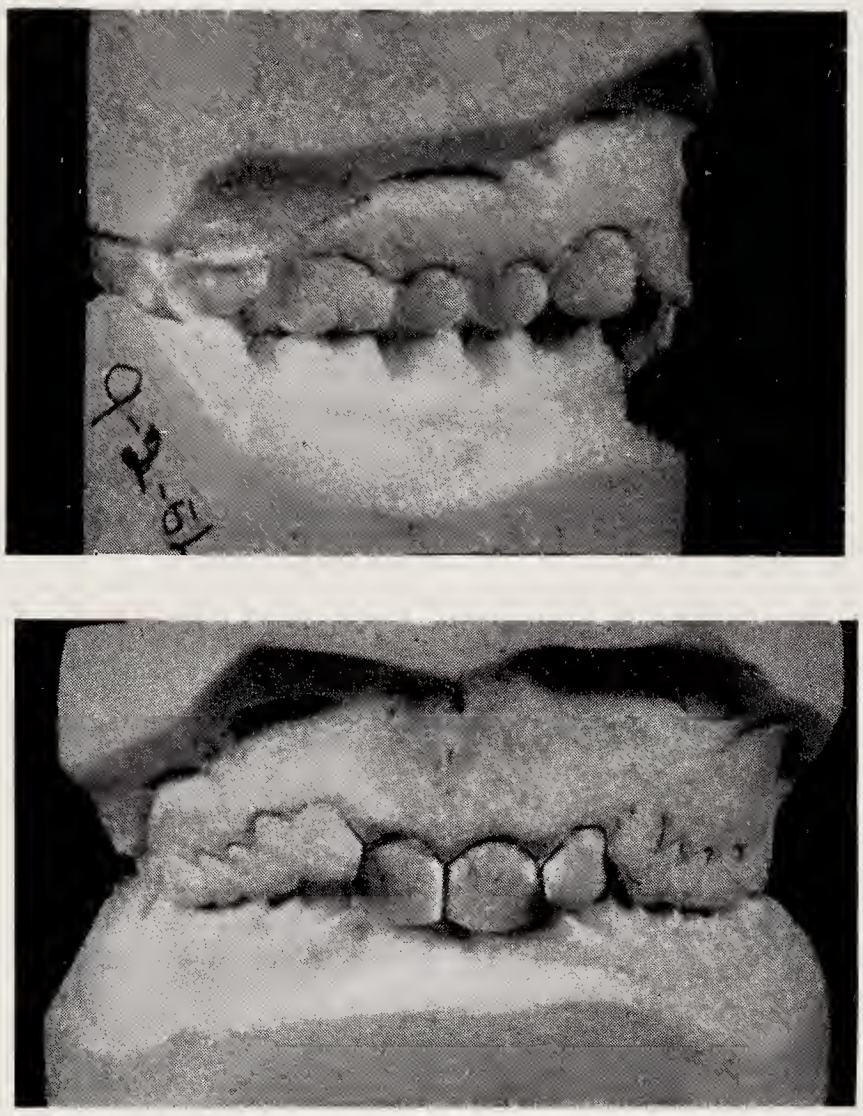
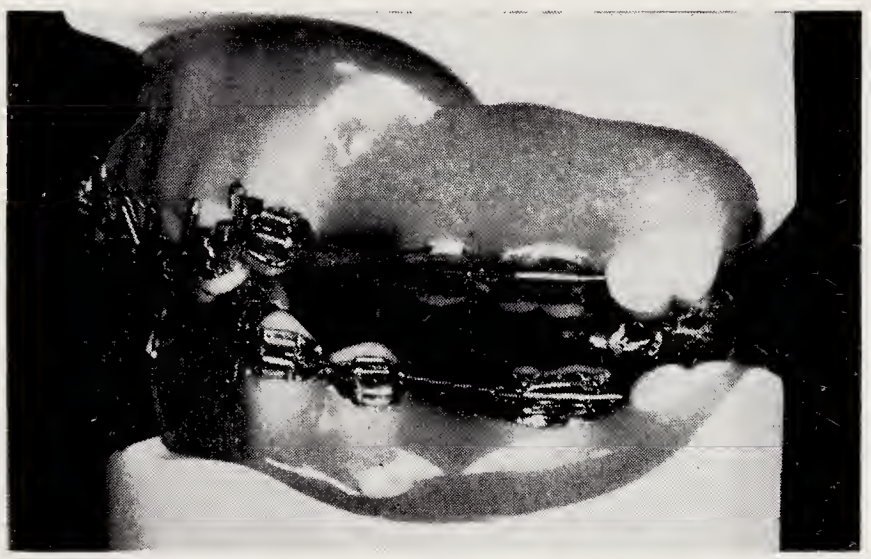


Fig. 2.—B, Showing the malocclusion in the case of Margaret.



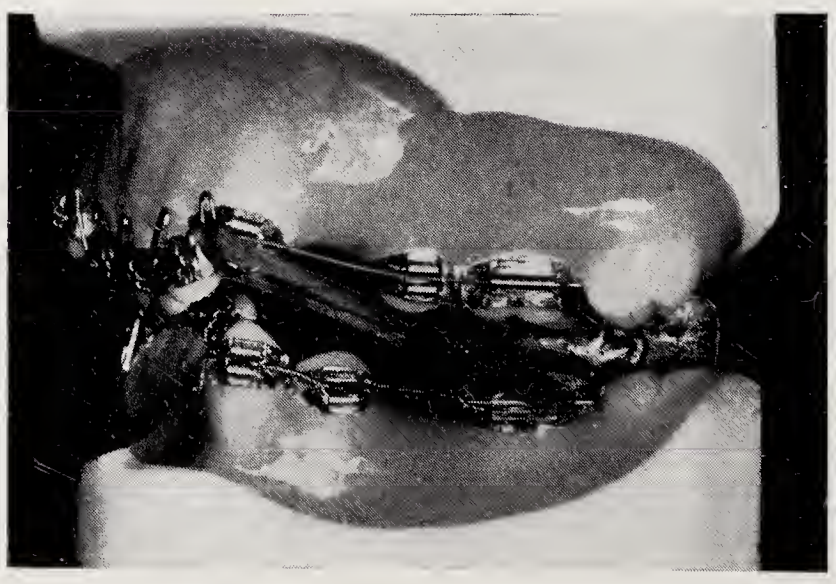


Fig. 3.—B, Showing the appliances used in the case of Margaret (div. 2). Note both the inter- and intramaxillary traction with elastics and coiled springs, and the Begg type of arch-wire for palatal root torque of the upper incisors.

identical result as possible within the bounds of soft-tissue behaviour.

At first, the treatment of Cecily (div. 1) consisted of slight anteroposterior expansion in the lower jaw with a lingual arch-wire, with the intention of relieving the slight crowding and at the same time helping to reduce the incisor overjet. It was soon realized, however, that the resultant over-proclination of the lower incisors would not be stable in soft-tissue balance. The correct treatment to relieve this crowding and to reduce the incisor overjet necessitated the extraction of two teeth in each jaw, followed by retraction of the upper anterior teeth.

With Margaret (div. 2), after the initial fitting of a bite-plate, it became evident that similar extractions were necessary to relieve the crowding and reduce the overbite. Consequently $\frac{4|4}{5|5}$ were removed from both twins and intermaxillary traction with multiband appliances instituted (*Fig.* 3).

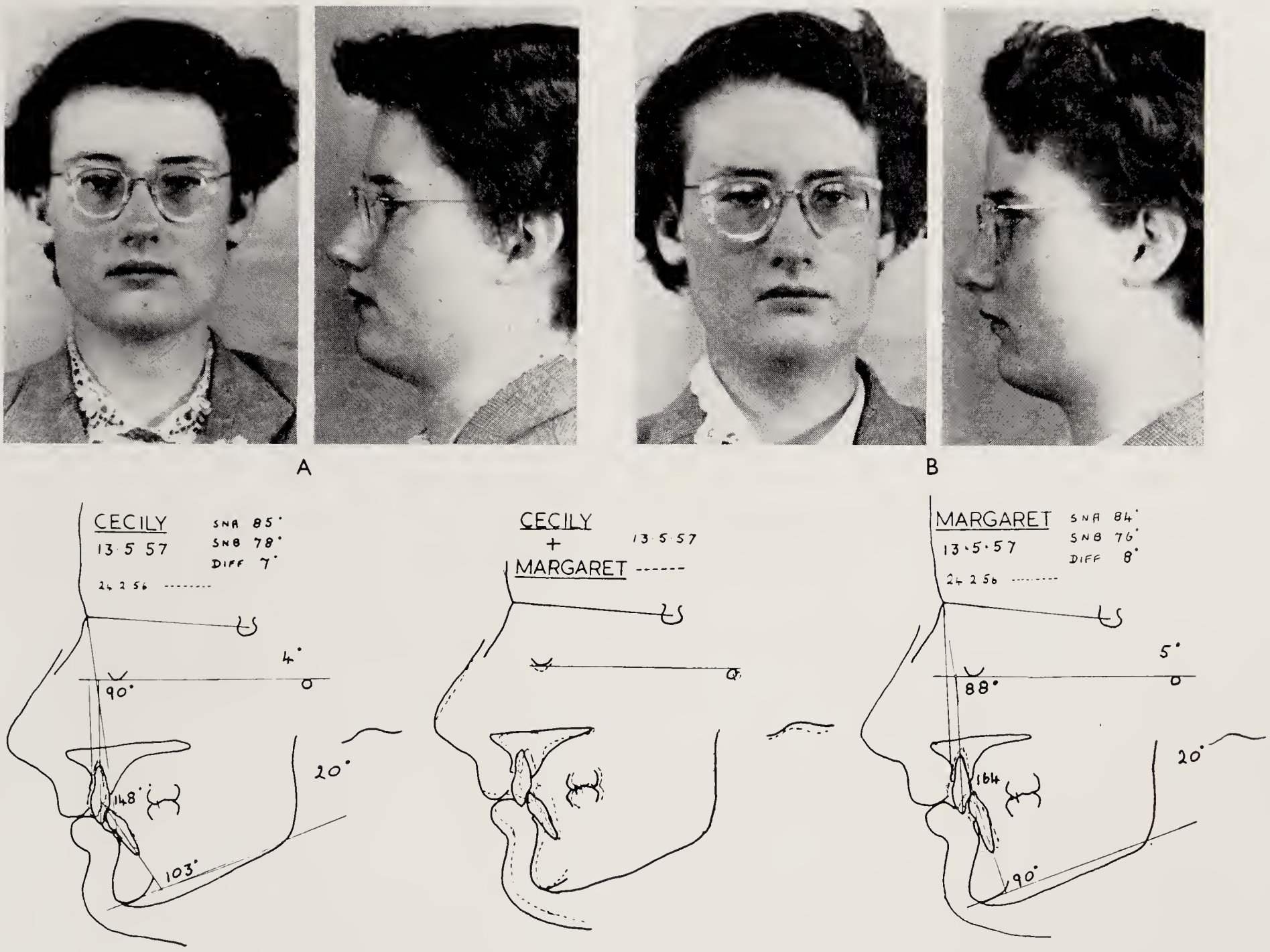


Fig. 4.—Final photographs and tracings of Cecily (A) and Margaret (B). The dotted outlines are the incisor positions on removal of retention appliances. Final composite tracing of Cecily and Margaret showing the more distal position of the dentition in the latter.

TREATMENT

A summary of the individual treatment is as follows:—

Cecily (*division* 1).—

November 2, 1954. 0·020 in. labial arch-wires fitted in both jaws, freely sliding in buccal tubes on the first permanent molars, with coiled springs to retract $\overline{4|4}$ and third power bends to aline the lower anteriors. Intermaxillary traction to retract $\underline{321|123}$ and

pull $\overline{6|6}$ bodily forward closing residual $\overline{5|5}$ gaps.

September 9, 1955. Upper anteriors now retroclined back to post-normal lowers. Palatal root movement of $\underline{21|12}$ instituted by means of a Begg type arch-wire.

Margaret (*division* 2).—

November 2, 1954. 0·018 in. labial arch-wires fitted in both jaws, the upper being stopped in front of the buccal tubes, and the lower free-sliding with coiled springs to retract $\overline{4|4}$ and sprung to depress $\overline{21|12}$. Intra-maxillary traction elastics from $\underline{3|3}$ to $\underline{6|6}$ to retract the upper canines.

April 26, 1955. New 0·018 in. arch-wires fitted in each jaw, free-sliding, and inter-maxillary traction to move $\underline{21|12}$ roots palatally with the Begg type upper arch-wire and pull $\overline{6|6}$ bodily forward closing residual $\overline{5|5}$ gaps in the lower.

In both cases, the bands were removed on February 24, 1956, and an Andresen appliance fitted for retention. These were removed on December 3, 1956. The active treatment time was approximately 15 months, with 9 months' retention.

Final photographs, models, and lateral radiograph tracings six months after the removal of the retention appliances show the marked improvement in the incisor relationships and the similarity of the two occlusions in both cases (*Figs.* 4, 5, and 6). In the division 1 case there was only a slight relapse due to an over proclination of $\overline{21|12}$ during treatment, and the subsequent lingual collapse of the incisors. The upper incisors are now stable inside the behaviour of the lower lip, even though there is still a very slight tongue thrust.

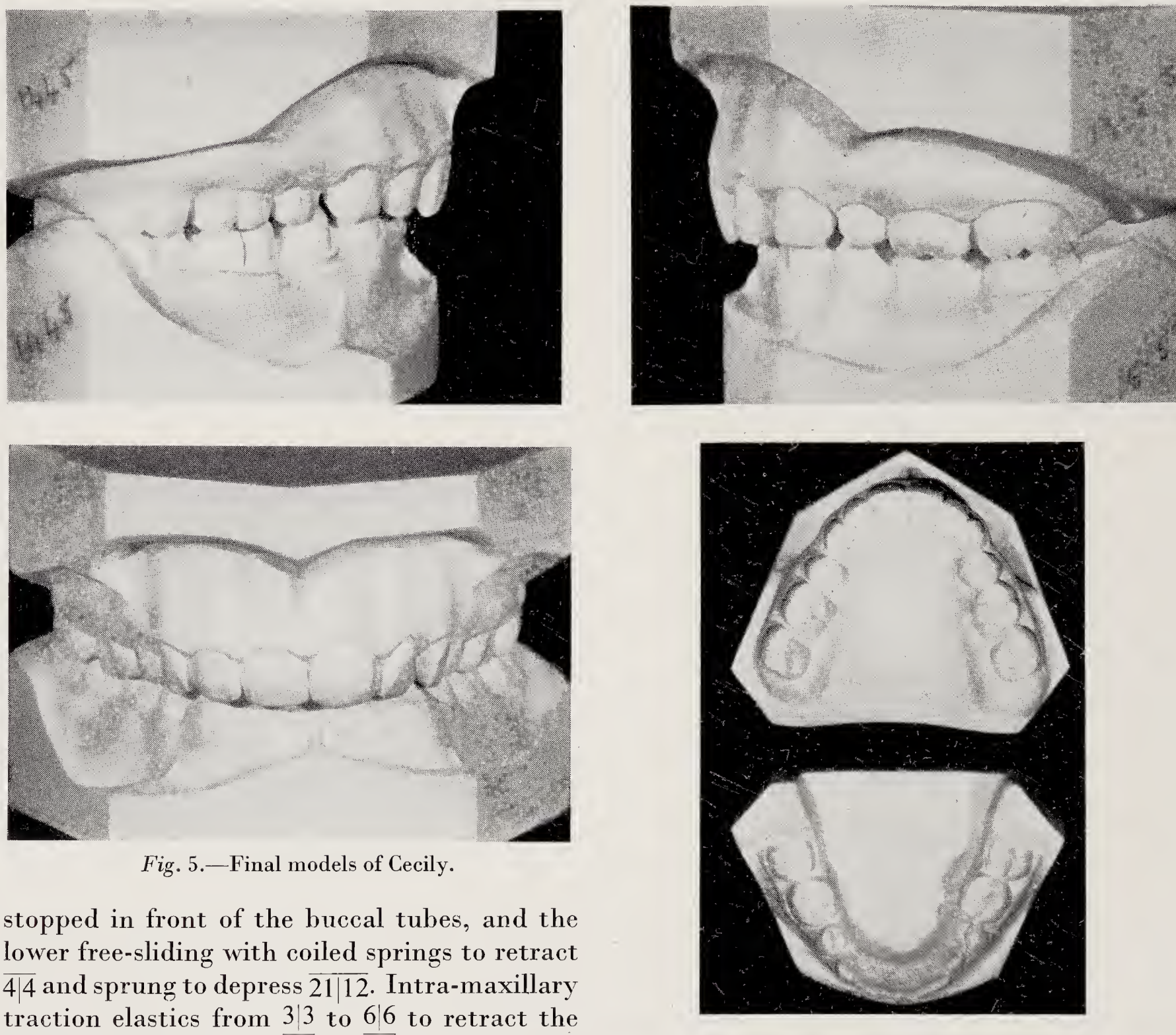


Fig. 5.—Final models of Cecily.

A slight relapse of the incisor crowding and overbite was also evident in the division 2 case, again due to lingual collapse of the lower incisors, and in this case a relapse of the palatal root movement of the uppers.

Both cases show clearly the very limited amount of proclination of the lower incisors permissible during treatment to ensure their ultimate stability in soft-tissue balance.

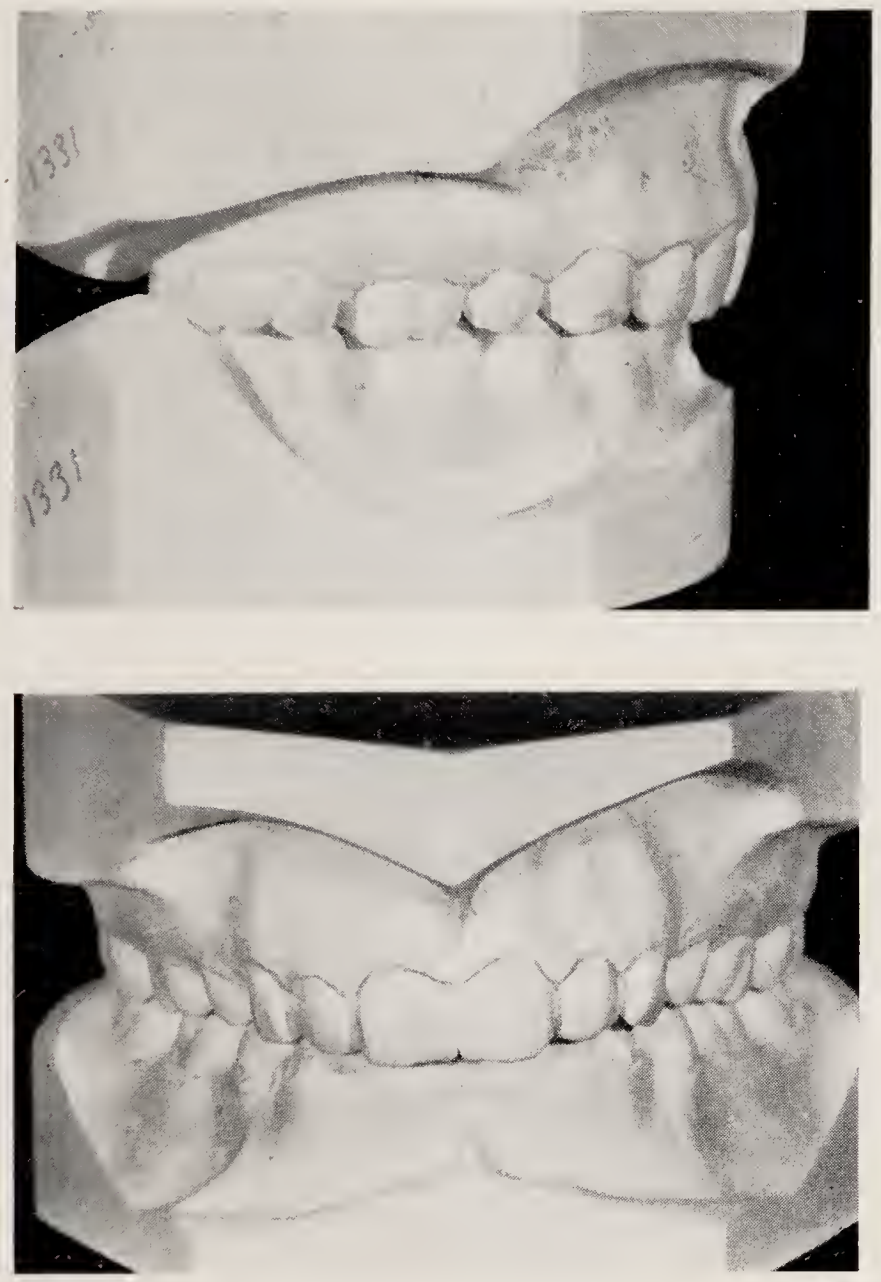


Fig. 6.—Final models of Margaret.

An interesting feature in both cases was the alteration of the path of closure of the mandible from the originals to a slightly forward path at the end of active treatment (about 30° to the vertical component), and a reversion to the original path after the slight lingual relapse of the incisors.

Equally as interesting is the fact that, although in the final composite tracings the general skeletal and soft-tissue patterns are very similar, the dento-alveolar structures in the division 2 case are stable in a slightly more distal position on their respective apical bases than in the division 1 case. This must surely be due to a different force of behaviour of the soft tissues between the two cases, especially that of the anterior circum-oral musculature.

No change in the respective dental base relationships was observed as a result of treatment.

COMMENT

The cases I have described prompt one to consider the aetiology of Angle's Class II, division 1 and division 2 malocclusions, and to speculate how sharp is the dividing line between the two.

It is generally accepted that the post-normality of the apical bases in both cases is

endogenous, but what are the causative factors concerned in the respective incisor relationships? Ultimately these seem to be determined by the relationship of the upper incisors to the soft tissues at rest and in function—factors which are also in the main endogenous in origin.

Whether the upper incisors erupt labially to the lower lip into the division 1 position or lingually to it into the division 2 position must initially be determined by something other than just chance.

Here such factors as the skeletal pattern, developmental position of the teeth, the behaviour of the tongue during swallowing, the constraining influence of the upper lip, and lastly, habits, must surely play an important part both in the aetiology and the ultimate stability after treatment. These factors are described more fully in recent papers by Ballard (1956, 1957).

The choice of extractions may well call for further comment, as it is generally assumed that extractions in the lower dental arch in postnormal occlusions should be avoided at all costs in order to prevent collapse of the lower arch. Where crowding is present in this arch to such an extent that it cannot be corrected by slight anteroposterior expansion, however, extractions are inevitable, especially for the purposes of reciprocal anchorage when inter-maxillary traction is being used. The second premolars were chosen rather than the first to lessen the risk of collapse, and the final models show that the posterior teeth have been moved bodily forward enough to close the extraction gaps completely—in fact so much so that there is still very slight crowding.

I would like to reiterate my thanks to Mr. Hovell, the Director, and to Mr. Walther, the Reader, in the Orthodontic Department of the Royal Dental Hospital for their help and permission to publish this case, and to the X-ray and Photographic departments concerned.

My thanks are also due in no small way to the patients themselves and the excellent co-operation of their parents.

REFERENCES

Ballard, C. F. (1956), *Trans. europ. orthod. Soc.*, 44.
— — (1957), *Dent. Practit.*, **7**, 269.
Leech, H. L. (1955), *Ibid.*, **5**, 341; *Trans. Brit. Soc. Orthodont.*, 72.

DISCUSSION

The President congratulated Mr. Leech on the time that he had given to the presentation of the cases. There was plenty to discuss; they had all seen Class II, division 1 malocclusions in which the morphology was very similar to that of a Class II, division 2, except that the upper incisors were in front of the lower lip, and they often wondered why they were division 1 instead of division 2. The cases shown indicated how this might happen; one person could have the morphology of a Class II, division 2, and then by a tongue behaviour or slight variation of Class II dental base relationship the upper incisors came down in front of the lower lip.

Mr. Leech was also to be congratulated on the treatment of the cases. His stable end-result seemed to support the view that basically the morphology in these cases was Class II, division 2.

Mr. J. R. E. Mills said Mr. Leech had said that the position of these incisors could not be due to chance. The President had remarked on the close similarity between Class II, division 2 and a certain type of Class II, division 1 malocclusion. It seemed to Mr. Mills that only a minor difference—perhaps of skeletal pattern—was sufficient to tip the balance between proclined and retroclined incisors. There was no intermediate position since the incisors must be right inside or outside the lower lip. He would suggest that the difference between Mr. Leech's patients was more apparent than real. Mr. Leech had referred to the present condition as stable. Had he not also said that the teeth had only been out of retention for six months, during which there had been some relapse?

Mr. H. Schachter asked Mr. Leech whether he had ever seen a Class II, division 1 on one side and a Class II, division 2 on the other side. What would he suggest in such a case?

The President said he was surprised that there had been no comments on the technique of the treatment described.

Mr. Leech, in reply, said he agreed that there might be a factor of chance in the morphology of these cases but he had been afraid of putting too much emphasis on it. Since they had intended to have a paper on statistics, there was no reason why he should not introduce some statistics. Taking 400 people attending an ear, nose, and throat clinic, and dividing up the Class II, division 1 and the Class II, division 2, it had been found that 28 per cent of the total were Class II, division 1, and 9 per cent were Class II, division 2. The main differences betwcen the two seemed to be that the lips were much more competent in Class II, division 1 cases; there was a greater record of abnormal

swallowing and tongue thrusting in the Class II, division 1 cases; and there was a slightly more obtuse angle of the mandible in the Class II, division 2 cases. It might be that it was chance which caused the incisors to fall into various positions, but he thought there was far more to it than that.

He had been asked whether he had seen a case of Class II, division 1 on one side and Class II, division 2 on the other side. When he had been at the Eastman Dental Hospital and had given the original paper, Mr. Baldwin had commented on this but had not given a definite explanation of it. Mr. Leech certainly did not know the reason for such a case. Perhaps Mr. Mills knew.

In the Class II, division 1 case of the twins, there had been slight crowding in the lower jaw, but he would not normally extract lower fives to carry out this treatment; normally he would be content to extract the upper fours and would treat the cases with removable appliances—a canine retractor followed by a high labial bow and apron spring. The cases had, in fact, been treated with fixed appliances mainly to see what the ultimate differences would be between them.

The President said it had been a most interesting communication, and he was sure they wished to thank Mr. Leech.

The vote of thanks was carried with acclamation, and the proceedings terminated.

THE USE OF CONTOURED CANINE ORTHODONTIC BANDS*

By **DORIS R. RIDLEY,** L.D.S. R.C.S.

EVEN the most experienced of us must have had difficulty in making well-fitting orthodontic bands for some canine teeth. This is due to the shape of the teeth, which are conical and often bulbous on their buccal surfaces.

Making canine bands from straight strips of stainless steel is both difficult and time-consuming. A well-fitting band cannot be made merely by pulling-up from the palatal aspect. (*Fig.* 1.) It has to be shaped by cutting and welding, or soldering, to produce the contour. If pulled-up from the buccal aspect, sometimes a better fit is obtained, but the resulting band is at too high a level for accurate bracket placement. A third alternative is to shape the band by cutting and soldering before pulling up around the tooth.

All these methods are time-consuming and often the finished band is unsatisfactory.

While I was in the United States, I noticed that pre-contoured orthodontic bands were in use, which ensured a good fit in considerably less time. These bands are manufactured by being cut in a curved pattern from sheets of stainless steel, and then contoured in a convex manner in the vertical direction in that part of the band which will be placed on the buccal aspect of the tooth.

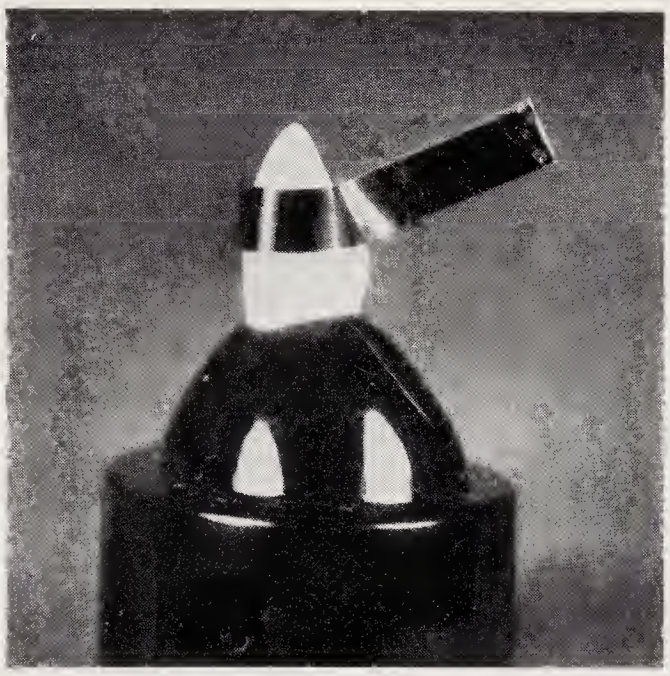


Fig. 1.—Straight band material pulled up from the palatal aspect of a canine tooth. It is seen to be ill fitting on the buccal aspect.

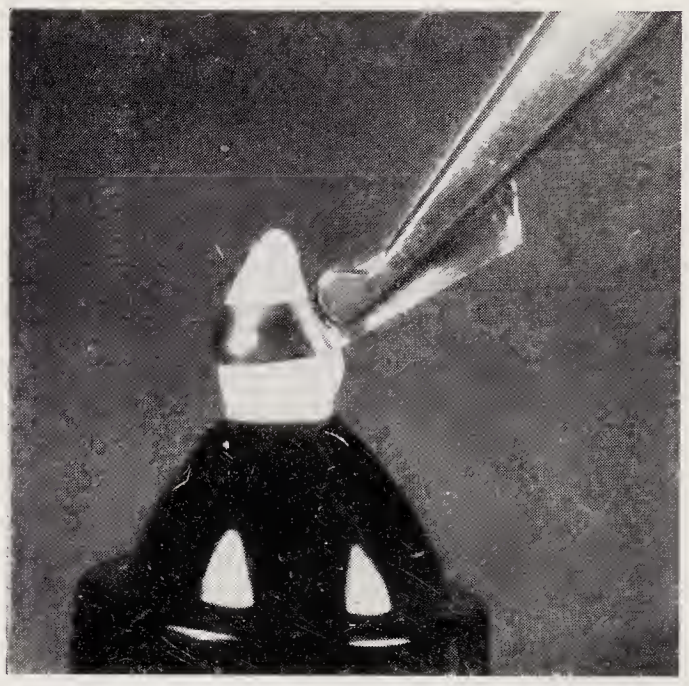


Fig. 2.—A contoured canine band being adapted. The contour of the band fits the buccal surface of the tooth.

They are adapted to the tooth merely by pulling up from the palatal aspect with an ordinary pair of Howes pliers, and cut and soldered, or welded, at the palatal join. (*Fig.* 2.) Thus a well-fitting band may be made very quickly.

The brackets may be added before adapting or placed on the finished band. In order not to destroy the contour, it is best to slightly curve the bracket with pliers and attach to the band by welding with an electrode shaped to fit the contour of the band. These contoured bands are now obtainable in England.

Given at the meeting held on October 14, 1957.

DISCUSSION

The President said he knew that the Americans had been having difficulty in making canine bands which would stay on, because a number of orthodontists cast them. The development described by Miss Ridley had taken place since his visit to America. Miss Ridley had answered most questions by giving the name and address of the firm which supplied these bands.

Mr. J. S. Beresford congratulated Miss Ridley on her presentation. Discussing the matter before the meeting, he had said: "This young lady will tell us about something she has seen in America but which we cannot get here." In fact, she had given them the address of the firm which would supply the bands.

Mr. J. H. Hovell congratulated Miss Ridley on her energy in getting the bands made in this country. She had returned from America full of enthusiasm for them and, as a result of her efforts, had succeeded in getting them made here. Anyone who had tried to get anything made in this country knew how difficult that was. This had made the fitting of canine bands much easier for those in practice. Instead of having to wire a piece of lead around a wide strip, spending hours on it, they could fit the new bands very quickly.

The President said everyone would congratulate Miss Ridley and express thanks to her.

The vote of thanks was carried with acclamation.

DEPRESSION OF LOWER INCISORS

By **R. T. BROADWAY**, M.D.S. (Lond.), F.D.S., D.Orth. R.C.S.

THERE has been in the past some controversy as to whether or not the lower anterior teeth are depressed into the alveolus when an anterior bite-plate, or lower multiband appliance with an arch to exert a depressing force on the lower anteriors, is worn. Salzman says: "that whether elongation of posterior teeth or depression of anteriors takes place when a bite-plate is worn is not fully settled".

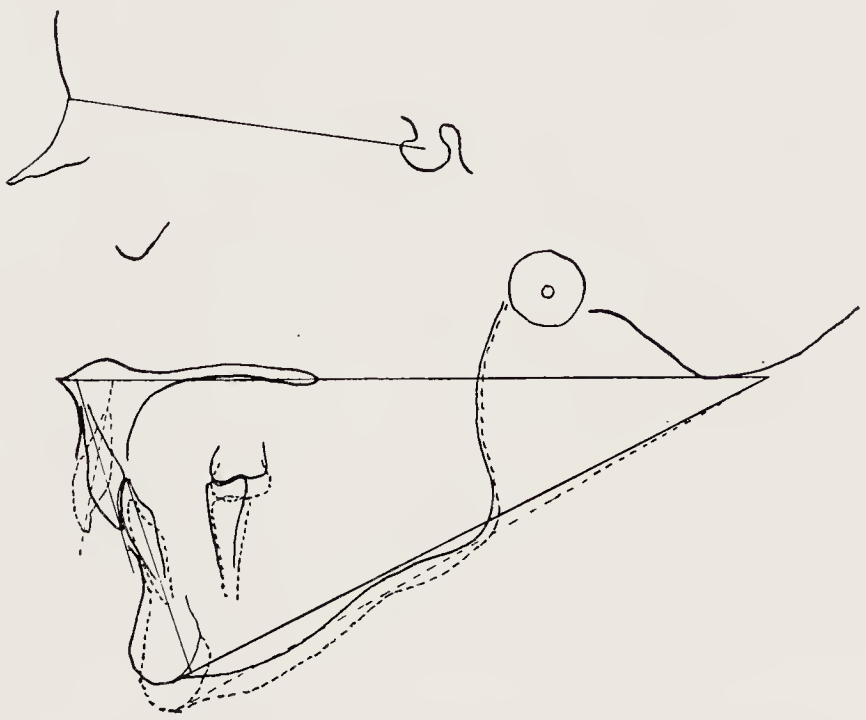


Fig. 1.—*Case* 1. Tracings of lateral skull radiographs, superimposed on S–N plane, of a patient who has worn an anterior bite-plate for two years.

There have been some previous investigations into the action of the anterior bite-plate, and recently Ilhan Belger (1956) reviewed the literature and undertook a cephalometric analysis of growth in subjects wearing bite-plates. He found that there was no discernible depression observed in the lower incisors, but that most of the vertical increases were in the posterior region, the premolars and molars having developed vertically into occlusion. It is a well-known clinical fact that when a tooth is extracted the opposing tooth will continue to develop vertically, until in some cases it actually occludes with the opposing alveolus.

It is not difficult to postulate then, that when the posterior teeth are separated by the wearing of an anterior bite-plate, they will continue to develop vertically until they occlude. It must be stressed that if this is to occur the bite-plate must be worn at all times. The vertical development of the cheek teeth thus results in a decrease in the overbite, which may give the clinical impression that

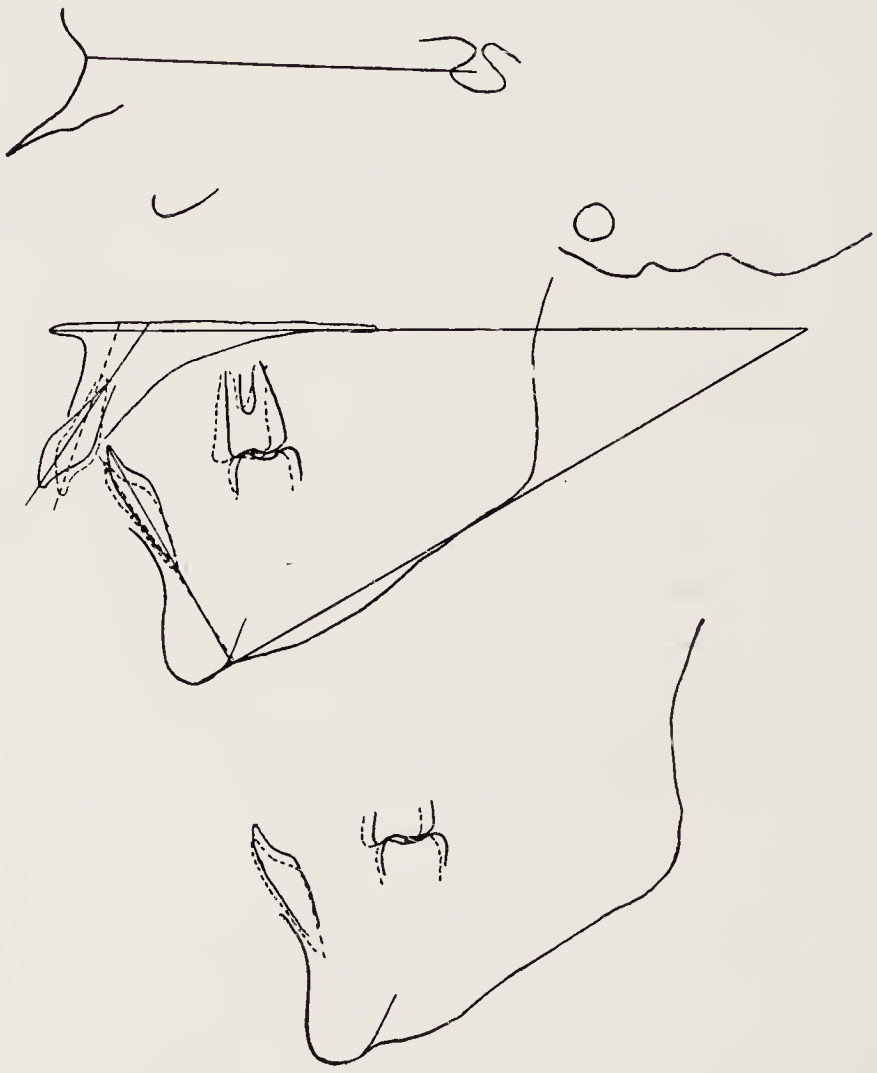


Fig. 2.—*Case* 2. Tracings of lateral skull radiographs, superimposed on S–N plane, and, the lower, tracings of the mandibles superimposed, showing depression of the lower incisors by means of multibanded appliances.

the lower anteriors have been depressed. This, although it may explain the reason for the further vertical development of the posterior dento-alveolar structures, does not explain why the lower anteriors are not depressed; it may well be that the patient wearing a bite-plate develops a reflex avoiding action, and that as soon as the teeth contact the bite-plate muscular relaxation takes place. Thus, little, if any, depression of the lower incisors occurs.

Given at the meeting held on October 14, 1957.

I put this forward as a possible hypothesis. I have studied a number of lateral skull radiographs of patients who have been wearing bite-plates, but so far have not found any significant depression of the lower incisors.

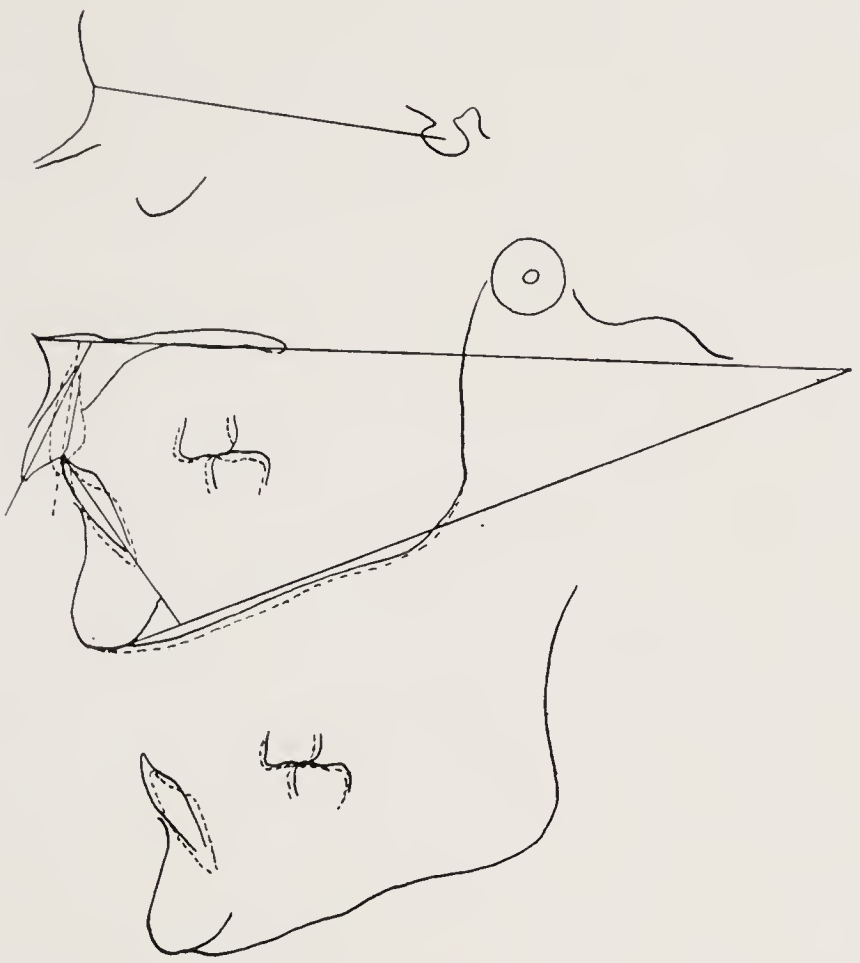


Fig. 3.—*Case* 3. Tracings of lateral skull radiographs, superimposed on S–N plane, and, the lower, tracings of the mandibles superimposed, showing depression of lower incisors by means of multi-banded appliances.

I have selected the following case as an extreme example of vertical development of the posterior teeth.

Case 1. (*Fig.* 1.)—The patient is an adult, with a Class II, division 2 malocclusion, who has conscientiously worn a bite-plate for two years. The tracings are superimposed on the S–N plane and it is seen that the posterior teeth have developed vertically to a considerable extent, but the lower incisors have not been depressed. In fact the bite has been opened.

Thompson (1946) has shown that the mandibular position in relationship to the head is established by three months of age. Thereafter it does not change and all attempts to increase the vertical height beyond that established by the rest position will fail. Not only does the mandible return to its resting position but invariably establishes a normal inter-occlusal clearance, or free-way space. Thus in the above type of case, if the bite has been opened beyond the normal rest position of the mandible, relapse will occur until the normal rest position is re-established.

In the case of the multi-band appliance, different conditions apply. With this type of appliance an active force can be applied to the lower anterior teeth, using the posterior teeth as anchorage. These anchor teeth are not held out of occlusion as they are when a bite-plate is worn.

Fig. 4.—*Case* 4. Tracings of lateral skull radiographs, superimposed on S–N plane, and, the lower, tracings of the mandibles superimposed, showing depression of lower incisors by means of multi-banded appliances.

An investigation was made into some of the cases that have been treated at the Eastman Dental Hospital. These cases had arches to actively depress the lower incisors at one stage during treatment. The lateral skull radiographs were not taken specifically to show depression of the labial segment, but as a routine during progress of the cases. Thus active depression has not necessarily gone on continuously between the dates the radiographs were taken.

The following cases were selected as they are adult or late adolescent, and growth changes are minimal.

The radiographs are superimposed on the S–N plane, and the lower tracings are of the mandibles superimposed.

Case 2. (*Fig.* 2.)—Class II, division 1 malocclusion treated with multiband appliances. There has been considerable depression of the lower incisors, with little or no elevation of the molars.

Case 3. (*Fig.* 3.)—Class II, division 1 malocclusion treated with multi-band appliances, showing depression of the lower incisors.

Case 4. (*Fig.* 4.)—A Class II, division 1 malocclusion treated by the edgewise arch technique—again considerable depression of the lower anteriors.

Thus we see that with a multi-band appliance the lower anteriors can be depressed into the alveolus. If at the end of treatment the lower labial segment is depressed so that it is out of occlusion, it will then develop vertically until it meets the upper labial segment or the palate. Where a bite-plate has been worn, and the posterior teeth have developed vertically into occlusion, they will be depressed into the alveolus when the bite-plate is removed, thus re-establishing the normal height of the bite and inter-occlusal clearance for that patient.

REFERENCES

BELGER, I. (1956), *Angle Orthod.*, **26**, 42.

SALZMAN, J. A. (1950), *Principles of Orthodontics*, 2nd ed., p. 808.

THOMPSON, J. R. (1946), *J.Amer. dent. Ass.*, **33**, 180.

DISCUSSION

The President said they were indebted to Mr. Broadway for producing his communication at very short notice, and in this respect they had probably not permitted him to do justice to the subject. He had produeed some important facts which might have been developed into a paper.

What had been demonstrated in these cases—and he was certain that they could be demonstrated in a large number of cases—was that a bite-plate did not depress the lower labial segment, whereas a multiband appliance would do so. In other words, they eould relatively depress a lower labial segment in a growing individual, because they could hold a labial segment in relation to the lower border of the mandible while growth developed. On the other hand, if they were trying to depress a lower labial segment in adults, it had to be done with a multiband appliance.

Mr. E. K. Breakspear said he had been very interested in the communication. He wondered whether Mr. Broadway felt that if the patient were encouraged to make an active movement on to the bite-plate, depression would occur in more cases. He often instructed his patients to use the bite-plate in this way and to work hard with it. Did Mr. Broadway think that might make a difference to the depression in some cases?

Mr. R. V. Shepperd asked what was the pathological effect of thrusting in a vertical force drawing the lower incisor 5 mm. into the body of the bone. Was there any risk of devitalizing these teeth?

Mr. D. F. Glass thanked Mr. Broadway for his short communication, and asked whether he had demonstrated that the teeth which had been depressed by the multiband technique advanced back to their original position, or did they remain in the position he had produccd, even three or four years later?

If the molars erupted in a bite-plate treatment, did they remain erupted?

The President said that once or twice he had had to depress cheek teeth in order to correct a lateral occlusion abnormality. Once he had been asked to depress a premolar because in an adult it had developed vertically and was preventing the construction of a bridge restoration. He had been interested to find that using a removable applianee, with a spring constructed to apply a gentle but positive and continuous pressure to the cheek teeth, they could be depressed. Although this could not be shown radiographically, he was convinced that the upper teeth to which the plate was attached did not develop vertically; in other words, intra-occlusal clearance in relation to the rest of the individual remained constant. It was a light, continuous, vertical pressure on the teeth which would depress them, as against the intermittent pressure of a bite-plate.

Mr. J. H. Hovell said that the President's remarks had been very germane; there was much more to be studied, and it was to be hoped that Mr. Broadway would continue working in this field, particularly in connexion with the difference between depressing incisors in young adults and children. It was easy to do it with young children, but all practising orthodontists had experienced difficulty in bringing about this result, with so-called removable appliances with bite-planes in young adults. Mr. Broadway had said that the multiband appliance might be necessary in certain cases. They found that using bite rehabilitation appliances the ineisors depressed and the normal intra-occlusal clearance was re-established.

Mr. H. E. Wilson said that in Mr. Broadway's first tracing—the case treated by the removable appliance—the mandible was not superimposed. It seemed that the lower molar was in the same comparative relationship with the mandibular incisor. In the case treated by fixed applianee Mr. Broadway had been able to demonstrate a marked difference in the occlusal level between the two teeth. Could he comment on that?

Mr. Broadway, in reply, thanked the President for his kind remarks about the paper. The President had answered Mr. Breakspear's question: the bite-plate was bitten on intermittently, whereas one needed a more continuous force to depress the anterior teeth. The continuous force was given by the multiband appliance and could not be obtained with a bite-plate. As far as he had gone he had not seen any depression of the lower incisors in this way, but he did not say that lower

incisors could not be depressed by the bite-plate and he intended to continue studying cases more fully. In the past it had been difficult to ensure that the bite-plate had been worn all the time, but he was collecting one or two cases in which it had been worn all the time in both young and old patients and he intended to take further radiographs and to make tracings.

Replying to Mr. Glass, he said that the lower incisors which were depressed would remain depressed providing they were in contact with the upper anteriors or the palate. If there were an open bite at the end of treatment, however, these incisors would erupt or develop vertically again until contact was made.

In the case mentioned by the President, in which a premolar had been depressed, a continuous pressure had been used, and the President had said that it was this continuous pressure which helped in the depression, which he felt would not have occurred with the intermittent pressure from a bite-plate. An active force had been used.

Replying to Mr. Wilson, he said there was more vertical development of the upper posterior teeth than of the lower. There was, however, some elevation of the lower molars. He had not done the comparison in the tracing of the mandible superimposed in the first case because he was primarily showing depression of the lower incisors, and when he came to do the tracings of the mandible superimposed he found that there had been no depression of the lower incisors. The two tracings would be identical as regards the incisors.

TREATMENT OF THE UNERUPTED MAXILLARY CANINE

By **M. A. KETTLE**, F.D.S., D.Orth. R.C.S.
Consultant in Orthodontics, King's College Hospital

THIS paper is intended to serve as a practical contribution to the diagnosis and treatment of misplaced maxillary canines. There are very few forms of canine impaction which will not respond to treatment with reasonable co-operation from the patient. It is hoped, however, that this may be seen in true perspective, as treatment for this condition is not always desirable nor necessary. Sometimes the buried tooth is better left where it is; sometimes it is better extracted, but where the patient will benefit from treatment designed to move this tooth into the arch no effort should be spared.

Provided that the canine has not impacted into the roots of the incisors, or cystic changes have not occurred around the tooth, very little harm results from leaving a canine buried in the palate. There is very little evidence that once the late teens have been reached there is any danger of resorption, death, or displacement occurring in the incisor teeth. The troubles in this respect usually arise in the younger patients, where they must be diagnosed and treated. In any case, periodic X-ray examination provides an adequate safeguard where a canine is known to be impacted but for some reason is not treated.

EARLY DIAGNOSIS

The treatment involved, in moving an impacted canine into place in the arch, is usually long and tedious and not without its particular difficulties. Prevention of this condition is obviously the ideal form of treatment. It should be common practice among all dental surgeons to palpate and register the position of the upper canines soon after the incisors have erupted into the arch. There should be a greater consciousness of canines at this stage in the development of the dentition. Provided that a slight bulge can be palpated high up in the buccal sulcus in good relationship with the adjacent teeth, the canine is likely to erupt into normal position, the exception being where a considerable displacement of the upper lateral incisor has occurred. Where this condition is present or the canine bulge cannot be identified, it is expedient to investigate the position of the tooth with X rays. Root resorption of an incisor tooth is usually initiated during the early eruption stage, particularly when the canine crown moves into the immediate vicinity of an incompletely formed apex of an incisor tooth. Marked displacement of a lateral incisor due to pressure from an erupting canine may be the first indication of this danger. Where it is not possible to discern the canine bulge by digital palpation, a simple intra-oral X ray may show whether the cause is quite innocent. On the other hand, much time and orthodontic treatment may be avoided by the early diagnosis of a canine which is being displaced into the palate.

PREDISPOSING CAUSES

The eruptive course of the canine is a long one, and because of this the tooth is more exposed to unfavourable influences during its eruption. Impaction occurs more commonly under certain conditions.

1. General Causes.—

a. Narrow upper arches which are deficient laterally in the inter-canine width.

b. Dental arches with a tendency towards deep incisor overlap and some retro-clination of the incisors. Where there is a reduction of canine space in the anteroposterior dimension.

c. Mouths which have suffered early loss of deciduous teeth, resulting in a reduction of premolar and canine space.

2. Local Causes.—

a. The presence of a non-vital deciduous canine tooth must be viewed with great

Given at the meeting held on December 9, 1957.

suspicion. A granuloma is capable of deflecting an erupting canine into the palate although there may be sufficient space for it in the arch.

b. Dentigerous cyst. It is probably no coincidence that misplaced canines are often surrounded by an enlarged tooth-follicle. The canine requires the presence of the adjacent teeth to guide it in its eruptive course. The cushioning effect of an enlarged tooth-follicle, and even more so with a dentigerous cyst, removes the influence of the adjacent teeth so that the canine is readily diverted from its proper course into the palate or the buccal side of the arch.

c. Congenital absence of $\underline{2|2}$. The absence of two teeth from the anterior part of the arch would be expected to simplify the natural eruption of the canine. In fact, the absence of the guiding influence of the upper second incisor permits a forward movement of the canine mesially to the roots of $\underline{C|C}$. The roots of these teeth then provide an excellent incline plane, down which the permanent canine slides until it moves into contact with the upper central incisor or is deflected into the palate.

d. Resorption of the temporary canine. Tardy resorption or lack of uniformity in the resorption of the root of the temporary canine may either prevent the normal eruption of or displace the permanent canine from the arch.

APPRAISAL OF THE POSITION OF AN UNERUPTED CANINE

The crux of the whole approach to this problem lies in a thorough examination of the patient. Before attempting treatment it is essential to gain a very accurate mental picture of the position and angle at which the canine is lying. There are many variations of the position in which the crown of the canine may be lying. It may be:—

1. Lying palatal to the arch.
2. Lying buccal to the root of the lateral incisor.
3. Impacted distally against the root of the lateral incisor.
4. Impacted vertically above the apices of the incisors.

The surgical interference required to reach and expose the buried tooth may be extensive and the region of approach will obviously be varied to meet the requirements of a particular case. This makes the pre-operative examination all the more important. Bearing in mind the above positions of the tooth, the following order of examination is usually employed:—

1. Digital palpation.
2. Visual examination.
3. Vitality tests of the teeth in that region.
4. X-ray examination.

The information obtained from a single form of examination is not taken entirely on its own merits but is correlated with or weighed against data gained from the other forms of investigation.

1. Digital Palpation.—

a. The Crown of Canine.—A firm bulge which can be palpated on the palatal side of the arch invariably indicates that the crown of the canine is lying in the palate and is not very deeply placed. Sometimes, however, the lateral incisor may have its root displaced palatally by the pressure of a canine lying on its buccal aspect. This situation also produces a bulge on the palatal side of the incisor. A tooth which is lying in a very deep position in the palate may not produce a palpable bulge.

The crown of a tooth which is lying on the buccal side of the roots of the upper incisors will invariably produce a bulge in the buccal sulcus.

In those cases where the misplaced tooth is lying in the alveolus distal to the root of the lateral incisor, vertically impacted above the incisors, or where there is congenital absence of the lateral incisor, it may not be possible to detect the position of the crown of the canine by palpation. The degree of looseness or firmness of the deciduous canine and the permanent incisors in the region of the buried tooth may be tested. Valuable information may thus be gained as to the proximity of the permanent canine to these teeth. Some indication is given of the degree of resorption in the deciduous canine and the possibility of resorption having occurred in the roots of the incisors.

b. The Position of Apex of Canine.—Where orthodontic treatment is to be attempted to move the misplaced canine into the arch, the limiting factor will often prove to be the position of the apex of the tooth. Fortunately the apex is commonly found to be lying above and buccal to the root of the first upper premolar. A fully developed canine in which the crown has been displaced into the palate shows a corresponding outward displacement of its apex. This may be palpated in the buccal sulcus above the apex of the first premolar.

2. Visual Examination.—

a. The Crown of Canine.—Working on the assumption that two bodies cannot occupy the same space, it is possible to determine the position of the misplaced canine by examining the axial inclination of the incisors. The crown of a misplaced canine which is deeply placed and lying on the palatal side of one or more incisors will cause an outward displacement of their roots. It is more common to find the root of the second upper incisor displaced in this manner. The effect of this movement will be to tilt the crown of this tooth inwards towards the palate, the exception being where the canine is lying just under the surface on the palatal side and pressing forwards on the coronal aspect of the incisor and tilting it forwards.

The pressure of the crown of the canine impacted against the distal aspect of the root of the second incisor will have the effect of displacing the root of this tooth mesially against the central incisor. The crown of the lateral incisor will be tilted distally, giving a clear picture of the position of the crown of the impacted tooth.

Pressure from the crown of a canine, lying on the buccal aspect of the root of the lateral incisor, will cause an inward displacement of its apex. This movement will show a corresponding outward deflection of the crown of the lateral incisor.

b. The Apex of Canine.—The presence of a misplaced or impacted tooth in the canine region will invariably provide topographical clues as to the position of its root. In addition to the displacement of the incisors by the crown of the canine, some changes may be detected in the alinement of the premolars. The presence of the root of the canine on the buccal side of the premolar usually results in the inward displacement of the apices of this tooth. This causes the crown of the premolar to be displaced buccally. Where the root of the canine is lying on the palatal side of the premolar the reverse effect may be seen or the premolar may even be rotated by this pressure.

3. Vitality Tests.—Heat, cold, and electric pulp tests may be made to determine the vitality of the incisors in the vicinity of a buried canine. Death of the pulp of an incisor sometimes occurs with or without root resorption of an incisor having occurred. This would be likely to influence the course of treatment and is better detected sooner than later. Root resorption of an incisor does not usually destroy the vitality of the tooth. Electric pulp tests show, however, that the pain threshold of the pulp may be lowered.

4. X-ray Examination.—The examination up to this stage will probably provide most of the information required to determine the approximate position of the canine, the exception being those patients with congenital absence of the lateral incisors. In the main, radiographs are used to confirm the findings of the clinical examination.

An intra-oral X-ray of the canine region gives valuable information of the proximity of the crown of the buried tooth to the roots of the incisors; the amount of bone overlying the buried tooth; the congenital absence of a lateral incisor; possible root resorption of the incisors; the presence of a granuloma at the apex of the deciduous canine; the presence of a dentigerous cyst in relation to the permanent canine; the deviation of the permanent canine from its vertical axis and the position of its apex. Where the tooth is lying in a grossly misplaced position, a second intra-oral view of the apical region is advisable from a different angle. Comparison of the two views will be of great value in assessing the position of the apex.

Stereoscopic occlusal radiographs are used to supplement the intra-oral view. Using the

prineiple of parallax, the precise relationship of the erown of the eanine to the roots of the incisors may be dctermined. Where there is any previous doubt as to whether the misplaced tooth is lying on the bueeal or palatal side of the areh, these radiographic views will provide that information. Further confirmation of the position may be made from a vertex-oeelusal view of the arch. This is taken with the X rays passing through thc vertex of the skull down the long axis of the incisors. This view is also of value in assessing the position of the apex of the canine.

Teeth which are very deeply placed and vertically impacted above the roots of the incisors require a lateral radiographie view. This is of value in assessing the position of the buried tooth in the anteroposterior plane, so that thc most eonvenient path of surgieal aecess may be determined. Sueh teeth commonly show a slight tendency to be bueeally plaeed.

INDICATIONS FOR ORTHODONTIC TREATMENT

There are many factors to be considered before deciding upon the course of treatment. Very rarely are all the indications favourable, but certain cr:teria must be fulfilled before a patient can be advised to undertake orthodontic treatment.

1. Value of the Canine to the Dental Arch.—This would appear to be a fundamental eonsideration, but it is very easy to eonsider the problem merely as one of a misplaced eanine to be brought into place and not one of restoring the whole arch to the best advantage. Mr. Walpole Day (1955) suggested that atrophy of the pulp sometimes oeeurs in an impaeted canine. It has also been asserted that the pinning of a buried canine is likely to be followed by death of the pulp of the tooth (Fastlicht, 1954). The first observation has not been confirmed in a limited number of eases investigated, and the seeond observation has not been borne out in any case treated.

Thc canine is generally considered to be the strongest rooted tooth in the areh and to be very pleasing æsthetieally. As such, the tooth is well worth eonserving. At times, howcver, when a eonsiderable degree of canine space has been lost, the first upper premolar makes an exeellent substitute for the canine. Where the eanine is in a very poor position and a good orthodontie result ean be aehieved without retaining it, the canine is better extracted.

2. Co-operation of the Patient.—A keen, co-operative patient is a great asset in any form of orthodontie treatment, but in thc treatment of an impaeted eanine it is a nceessity. Patients who habitually brcak appliances and those who are unlikely to eo-operate fully with applianees are considered a poor risk. A tooth with a pin in it has to be treated very carefully as constant rough usage may break or dislodge the appliance. It is not always possible to recognize a patient likcly to break appliances, but it is a good rule to insist that the paticnt is cxtremely keen to undertake the treatment required. In the older patient this is found to be more important than the parents' desire for treatment. A great eause of concern among teenage patients is whether the appliance is likely to eover the front teeth and be disfiguring as a result.

3. Age of Patient.—The majority of the patients refcrred for treatment arc betwcen 12 and 15 years of age. The condition is already well established at this age, but the teeth usually rcspond to orthodontie treatmcnt. Canines are difficult teeth to move, so that the older patients invariably require the extraction of a premolar to faeilitate treatment. The ideal age-group for treatment is between 9 and 12 years of age before the condition is well established.

4. Space Available.—The ultimate problem becomes one of providing sufficient space to aecommodate the permanent canine. The deciduous eanine is usually in position but space is invariably lost by the forward drift of the buccal segments. The younger the patient the better the prospect of providing room for the unerupted tooth within the arch. Where space has been lost in the older patient extraction of a premolar is usually required. Often a close relationship is present between the roots of the eanine and first premolar, so

that the choice of extraction is usually the first premolar. Sometimes it is difficult to justify the extraction of a premolar which is in good position in order to provide space for a buried canine which is in a poor position.

5. Difficulty of Treatment.—

a. Surgical Procedure.—It was said earlier that there are very few forms of canine impaction which will not respond to treatment provided that there is reasonable co-operation from the patient. Other factors are also of importance, such as the depth of the buried tooth and the position of its apex, also the degree of impaction as well as the age of the patient and the space available. Although the surgical technique is not particularly difficult after a few salient points have been mastered, it is not a method to be undertaken lightly. Many difficulties can arise, such as damage to the adjacent teeth and to the canine. The less favourable the position of the buried tooth the more these risks have to be considered.

b. Orthodontic Treatment.—It is fortunate that the apex of the canine is usually in a favourable position so that the orthodontic movement required is a tipping action. The crown undergoes most of the movement and little change occurs in the apical region (*Fig.* 1). Where the apex appears to be distally placed the orthodontic movement is still satisfactory as a rule. The spring-traction applied to the tooth will draw the tooth down in addition to the tipping action on the crown. This results in a form of follow-through movement in the apical region.

The farther forwards the apex is lying the more difficult does it become to move the canine into a pleasing position. In these cases there is a close relationship between the lateral incisor and the canine. Provided that the first premolar is a satisfactory tooth capable of being moved into good alinement, the emphasis of treatment is on extraction of the canine.

The depth of the buried tooth puts a proportionate limitation on the chances of success, as does the degree of impaction of the canine against the roots of the incisors. Pins are sometimes used to a great depth, and although they can be used successfully to reach down and bring about tooth movement, the other factors must be favourable. An extra strain by a heavy bite may be put on the pin which results in its displacement or fracture. The reduction of a severe impaction may increase

Fig. 1.—Radiographs of patient aged 15 years. To show movement of $\underline{|3}$ which has taken place with orthodontic treatment over five months. The movement of $\underline{|3}$ is primarily a tipping action of the tooth.

the amount of movement required to such a degree as to render orthodontic treatment undesirable even if not impossible.

A deep incisor overlap is often associated with this condition, and where this is severe a further hazard has to be considered owing to the danger of displacement or breakage of the apparatus. Sometimes this difficulty can be overcome by introducing the pin into the tooth from an alveolar or a buccal approach.

6. Root Resorption of Incisors.—The mechanism which initiates root resorption of an incisor tooth due to the close relationship of a buried canine to it is not clear, but it occurs often enough to deserve consideration. The movement of an erupting canine across the

apical region of a lateral incisor may be sufficient to cause resorption of the incisor root, although the canine may continue its eruptive course into normal alignment (*Fig.* 2). It is more common for the erupting canine to impact itself into the apical region of an incompletely formed incisor to initiate the resorption process, although this sequel does not invariably follow the impaction.

Early diagnosis is essential as the progress of the resorption process may be rapid. The

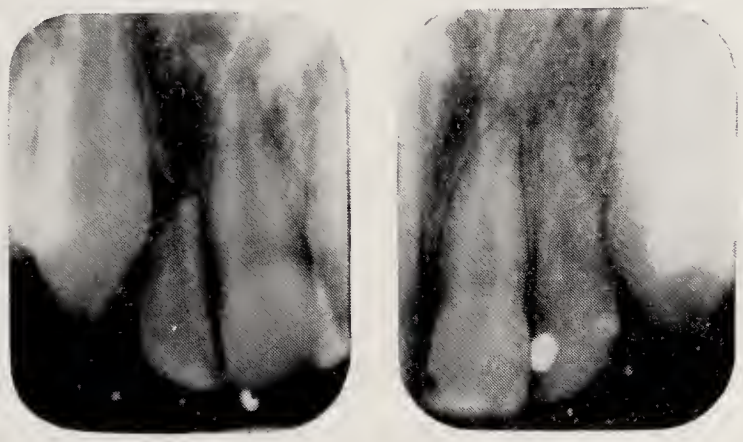


Fig. 2.—Patient aged 12 years. Radiographs show extensive resorption of $\underline{2|2}$ which occurred during the unaided eruption of the canines. Both teeth are vital.

disimpact the canine and move it away from the incisor root (*Fig.* 4). The orthodontic problem is made more difficult where the canine becomes impacted between the roots

Fig. 3.—Radiographs and photograph of extracted $\underline{2|}$ showing extensive resorption of this tooth due to the presence of an impacted canine. $\underline{2|}$ was extremely loose and extracted so that $\underline{3|}$ could be brought into position.

Fig. 4.—Radiographs to show congenital absence of $\underline{2|2}$ and extensive resorption of $\underline{|1}$ due to the impaction into it of $\underline{|3}$. Radiographs also show movement of $\underline{|3}$ into position with the aid of orthodontic treatment. $\underline{|1}$ is vital.

first indication of this occurrence may be the loosening of an incisor. At times resorption is so severe that the damaged tooth is better extracted to allow the canine to erupt into its place in the arch (*Fig.* 3).

Extraction of the incisor does not always give a pleasing æsthetic result. Where the lateral incisors are absent, and a central incisor has suffered resorption, it is essential to attempt orthodontic treatment to of the central and lateral incisors, causing resorption of their roots. During operation care must be taken not to expose the apical area of the incisor to infection.

Root resorption may continue after the canine has been moved away from the affected area. It is more common to find repair tissue laid down once the impacted tooth has been moved out of the area. A patient who had suffered resorption of both upper lateral

incisor roots due to the presence of impacted upper canines provides an interesting illustration. On one side the canine remained embedded into the root of the lateral incisor, and on the other side the canine had subsequently moved into alinement in the arch. These teeth were extracted and sections were made of them. Both teeth had normal coronal pulp-tissue and the tooth which had the canine impacted into it showed evidence of active root resorption and the presence of inflammatory tissue. The other tooth showed evidence of repair-tissue laid down after the canine had moved away from it. From this information it may be concluded that a positive attempt at repair is sometimes made in the root of a resorbed tooth, and it is also interesting to notice that the pulp-tissue remained normal in both cases.

7. Congenital Absence of $\underline{2|2}$.—The impaction of a canine in association with the congenital absence of a lateral incisor makes orthodontic treatment a necessity. There is a tendency in these cases for the canine to move mesially into contact with the root of the incisor. It may become displaced into the palate or remain impacted against the incisor. When this impaction occurs against the apical region resorption of the incisor root may take place (*Fig.* 5). There is a great danger under these conditions of the patient losing all the anterior teeth. Although marked root resorption may have occurred in the incisors, it is still important to move the canines into the correct position in the arch. In the event of an incisor being lost at a later date, the canine can be utilized as a bridge abutment.

8. Dentigerous Cyst.—A dentigerous cyst in association with an impacted canine is treated along the conventional lines of opening the cyst and allowing marsupialization to occur with the aid of a suitable pack. The tooth will often erupt as the cyst cavity fills in, but where this movement is not favourable a pin is placed in the tooth to enable controlled orthodontic movement to occur.

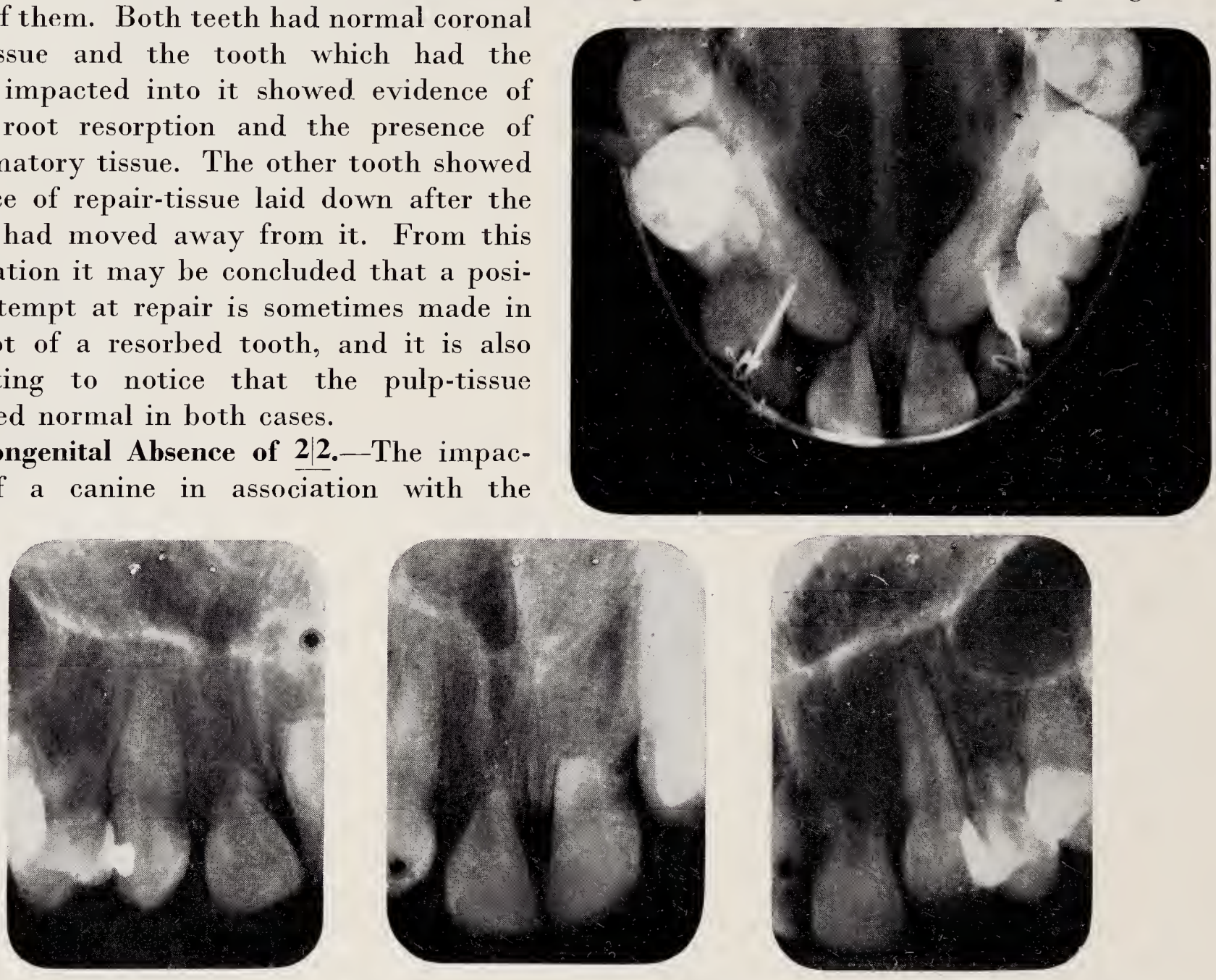


Fig. 5.—Radiographs to show extensive resorption of $\underline{1|1}$ associated with the impaction of $\underline{3|3}$. Patient, aged 12 years, had congenital absence of $\underline{2|2}$. Occlusal radiograph shows apparatus in position with pins inserted from buccal approach. Further radiographs show condition after $\underline{3|3}$ had been moved into position. There had been a continuation of resorption of $\underline{1|1}$. Both teeth are vital.

TREATMENT

Surgical Treatment.—

1. *Treatment by Extraction.*—The real emphasis must be put on early diagnosis and treatment. Where this has been done the extraction

of a temporary upper canine and possibly the first upper premolar will often allow a misplaced canine to erupt into a good position (*Fig.* 6). Where the congenital absence of a lateral incisor occurs, the temporary upper canine and temporary incisor, if present, teeth will usually erupt provided that a suitable exit is made for it in the overlying bone and palatal mucosa (*Fig.* 8). The deeper the tooth is lying the more care must be taken to prevent the palatal tissue from growing back and submerging the exposed tooth again.

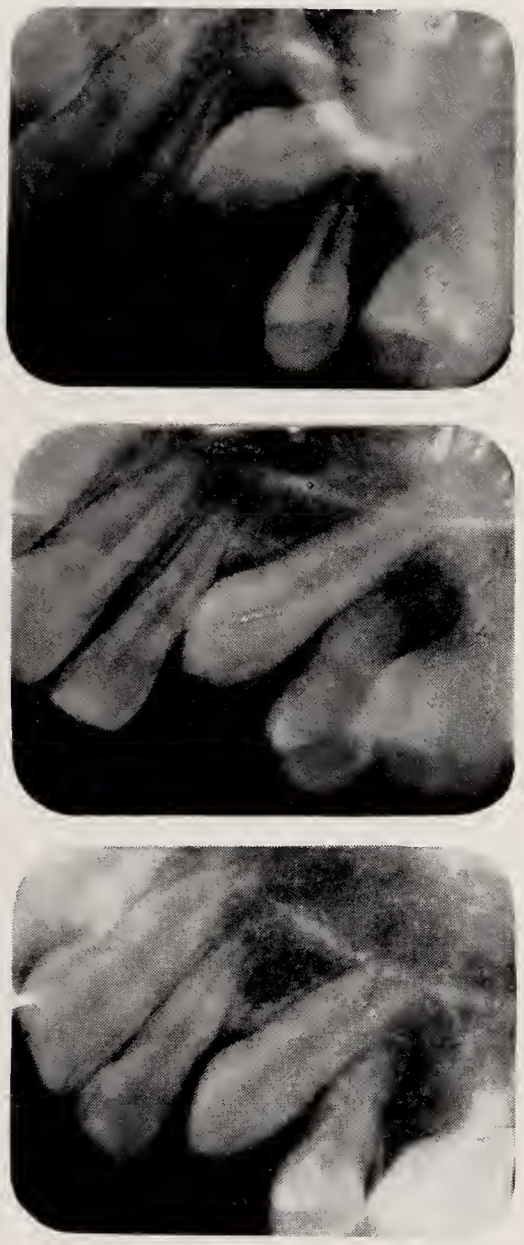


Fig. 6.—A series of radiographs showing the movement of $\underline{|3}$ in patient between 7 and 12 years of age in which $\underline{|3}$ has moved into position after the extraction of $\underline{|C4}$.

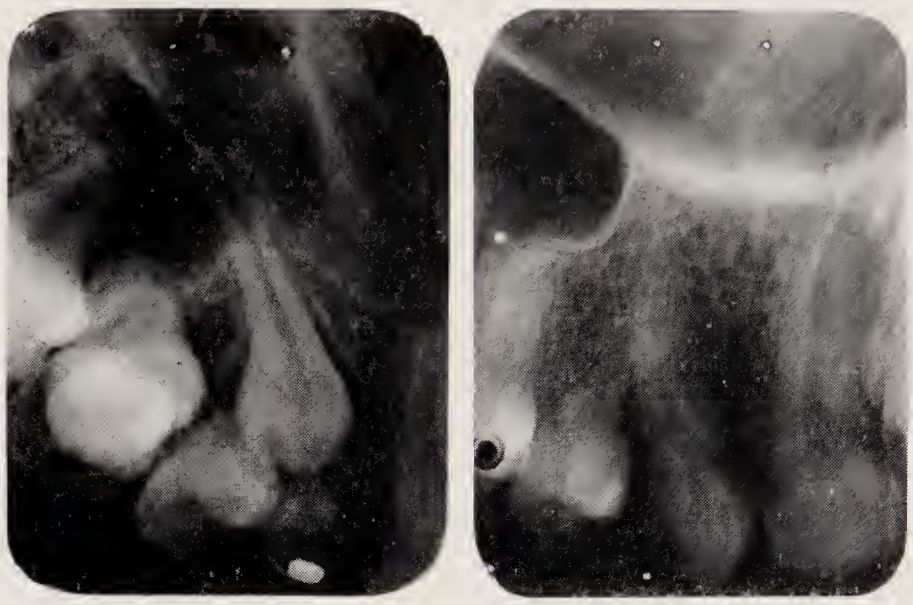


Fig. 7.—Radiographs to show impacted $\underline{3|}$ associated with arrested resorption of $\underline{C|}$. Patient, aged 13. $\underline{3|}$ has moved unaided into position after extraction of $\underline{C|}$.

Fig. 8.—Photograph taken from palatal view of patient with unerupted $\underline{3|}$, one week after section had been removed from overlying palatal mucosa to allow eruption of canine.

should be removed at an early date. The incline planes presented by the partial resorption of the roots of these teeth play a major part in the displacement of the permanent canine.

Occasionally resorption of the root of a temporary canine becomes arrested and prevents the normal eruption of the permanent canine (*Fig.* 7). Extraction of the temporary tooth together with the removal of any overlying bone will allow the tooth to erupt.

2. *Simple Exposure of the Unerupted Tooth.*—A canine which is lying near the surface and which is not impacted against the adjacent Zinc oxide and cotton-wool packs may be placed over the tooth to keep the mucosa back. The pack is changed at intervals of about a week until the tooth has erupted to the surface. During this movement the tooth may be directed into a better position if the pack is pressed down under pressure against the tooth in the appropriate direction. Black gutta-percha packs may be used in the same manner. After the tooth has erupted some difficulty may be experienced in obtaining sufficient purchase with an orthodontic spring

against the tooth. For this reason almost all the teeth which require active movement into position are pinned. This enables a positive force to be applied to the tooth in the simplest manner.

3. *Surgical Exposure and Pinning of the Unerupted Tooth.*—An impacted tooth which is embedded hard against the incisors or

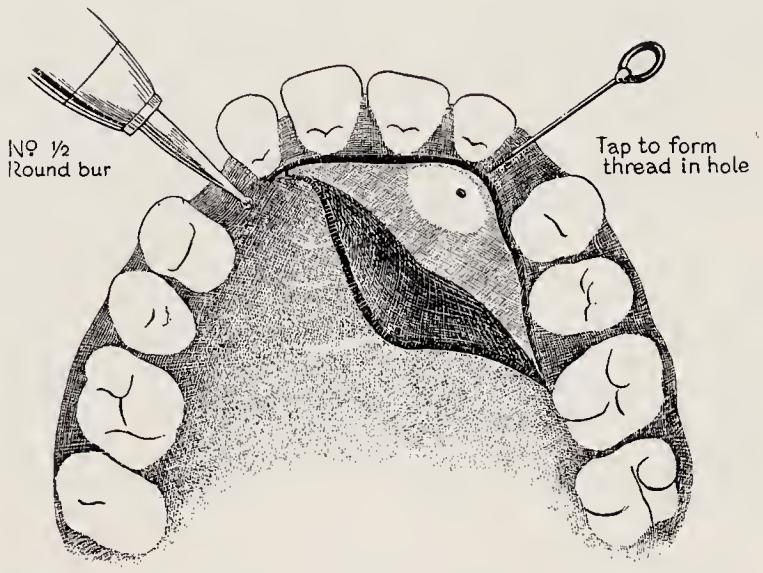


Fig. 9.—Diagram to show pinhole drilled with a No. ½ round bur, the entrance to the hole enlarged with a No. 1 round bur and the hole threaded with a tap of suitable size.

lying in a very poor position usually requires pinning so that controlled movement can be brought about. A tooth which is embedded into the root of an incisor or impacted hard against the root must be disimpacted before it can be brought to the surface. A technique is required which will give good results under adverse conditions without endangering in any way the adjacent teeth. A method which will not mutilate the canine tooth unnecessarily is to be preferred. The operative procedure is usually performed under a general anæsthetic. Visibility is the primary requisite to an efficient pinning technique. The infiltration of the area with a local anæsthetic is recommended to produce some reduction in local hæmorrhage.

a. Palatal Approach.—An incision is made in the palate against the teeth from the second incisor on the opposite side to a point mesial to the first permanent molar on the side of the unerupted canine. A large incision is preferable as it increases visibility and an incision in this position avoids the palatal vessels. The flap is laid back using a periosteal elevator until the whole area overlying the buried tooth is adequately exposed. The neurovascular bundle which passes through the incisive canal is preserved intact to prevent unnecessary hæmorrhage.

Overlying bone is removed with a large No. 10 round bur, working under the influence of a jet or spray of warm saline solution.

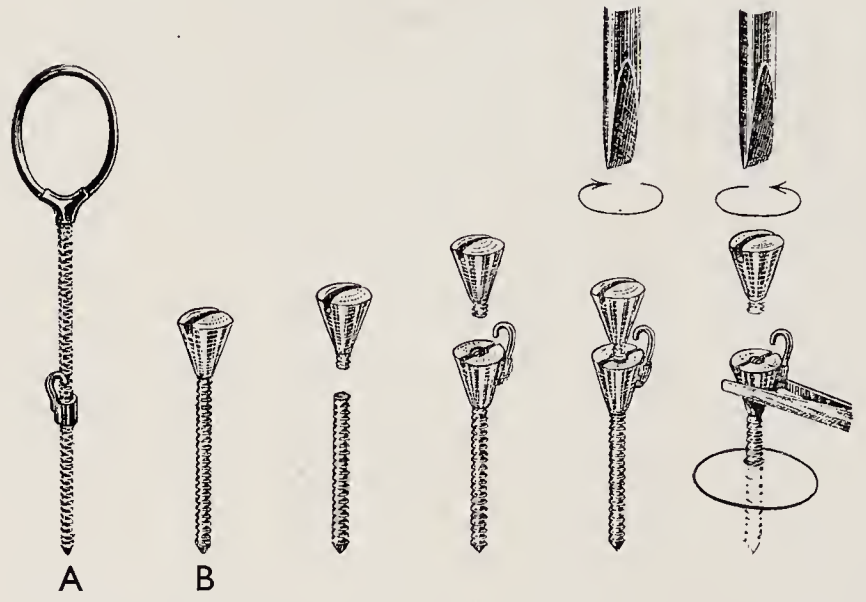


Fig. 10.—Diagram to show: A, Dentine screw with threaded collar and hook attached; B, Stainless-steel type of screw made by Wipla Co. Diagram shows the stages employed to facilitate the final cementation of the pin and removal of pinhead from inaccessible position without disturbing cement union.

The use of a saline spray increases visibility, reduces the traumatic effect of the cutting action of the bur, and reduces the local hæmorrhage. The buried tooth is found and exposed sufficiently to be able to identify its position and axial inclination. More bone is removed with a smaller No. 5 round bur from the distal side to provide an adequate exit for the tooth from the bone.

The most satisfactory position for the pinhole to be made is on the palato-distal aspect of the canine. The hole must be cut into dentine just inside the amelo-dentinal junction. The angle and position of the pinhole are decided largely by the position of the buried tooth, but it is convenient to arrange as far as possible for the pin to emerge through the palate at or near the incision line. The pinhole is cut with a No. ½ round bur into the substance of the dentine. The enamel opening is enlarged slightly with a No. 1 round bur as a necessary precaution against the enamel splitting when the hole is threaded. The thread can be made with a tap synchronized

with the size of the screw pin or if a tap is not available the pin will thread itself to some degree into the dentine. This threaded union between pin and dentine is a necessary

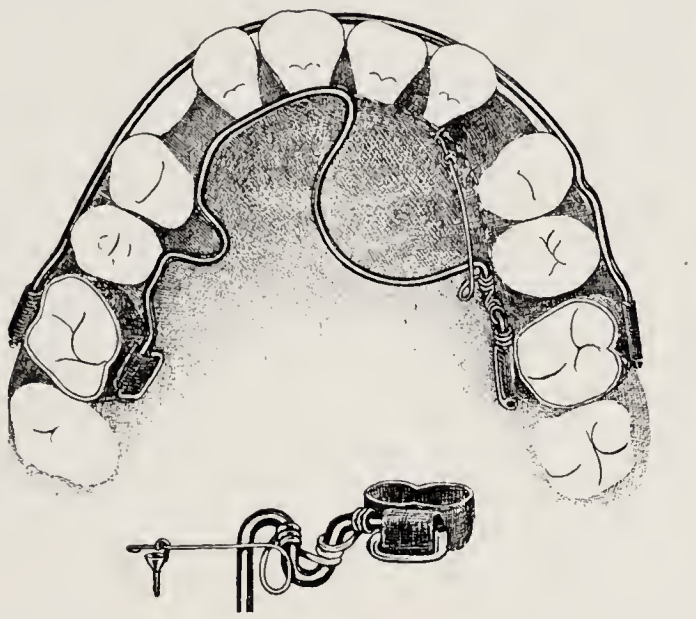


Fig. 11.—Diagram to show pin in position with hook projecting from palate. Apparatus in position and auxiliary spring in 0·3-mm. wire connected to hook.

safeguard against future dislodgement by the stresses and strains to which it will be subjected (*Fig.* 9).

The type of pin available is the dentine screw which can be re-threaded with a more precise thread using a fine watchmaker's die. To this pin is threaded a small collar made in brass or gold. A small hook in 0·3-mm. iridio-platinum wire is soldered to the collar with

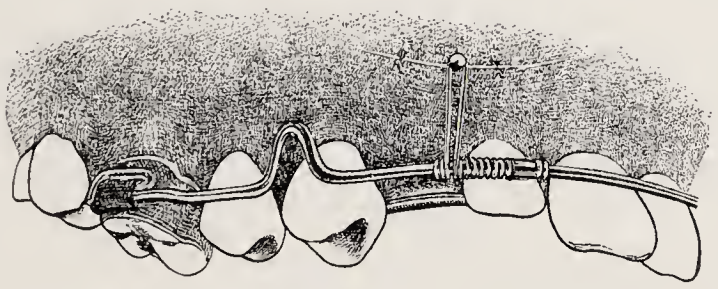


Fig. 13.—Diagram to show incision line, pin in position carrying small acrylic ball, and apparatus with auxiliary spring attached to move tooth impacted on the buccal side of the arch.

18-carat gold solder. In certain positions, particularly where the pin emerges from the buccal side, a small acrylic ball is attached to the dentine screw instead of the collar with a hook attached. This avoids irritation to the surrounding tissue. The other type of pin is made from stainless steel supplied by the Wipla Company. This has a removable threaded component to which a small hook

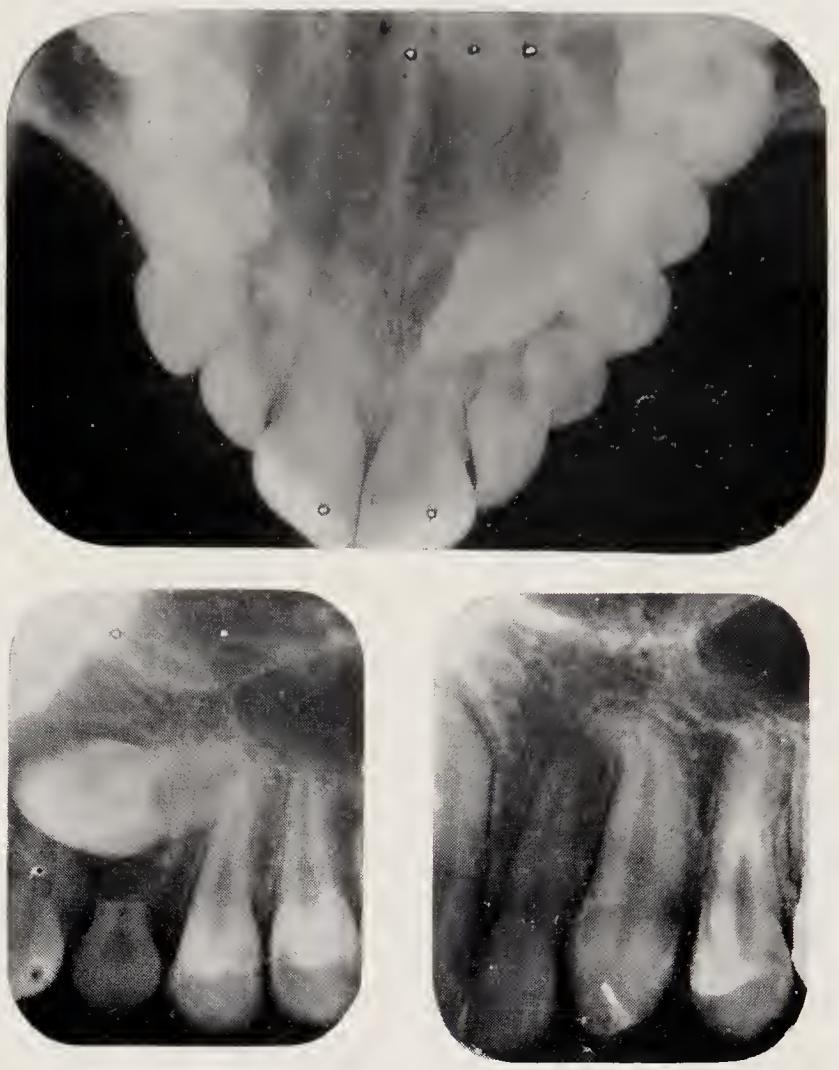


Fig. 12.—Radiographs to show result of treatment to move $\underline{|3}$ into position. The impacted tooth was horizontally placed and on the palatal aspect of $\underline{|2}$. Tooth was pinned from the palatal side and moved into position.

Fig. 14.—Radiographs to show result of treatment to move $\underline{3|}$ into position. Tooth was impacted against buccal aspect of $\underline{2|}$. A pin was inserted from a buccal approach and tooth was moved into position with the aid of a fine wire spring.

of iridio-platinum wire can be soldered with gold solder (*Fig.* 10). No other type of solder union has proved reliable.

The pin is threaded into the pinhole and then removed for cementation. The area is carefully packed with swabs and the pinhole is dried with paper points. Oxyphosphate cement is flowed into the pinhole with a spiral root-filler and the screw pin is threaded back into place. When the cement has set the excess portion of the pin is removed and the flap is sutured back into position leaving the hook projecting from the incision line.

It has proved very much more comfortable for the patient to allow the palate to heal together rather than to keep the space open with packs. As movement of the tooth occurs the excess amount of pin projecting into the palate can be disked away so that the hook is kept on the palate surface. By this means the projection of the pin into the palate is kept to a minimum, avoiding the risk of damage from the bite (*Figs.* 11, 12).

b. Buccal Approach.—An incision is made over the buried tooth into the buccal mucosa of sufficient length to allow adequate exposure of the tooth. The procedure is the same as for the palatal approach, but the pinhole is drilled into the buccal surface of the tooth towards its distal aspect. Where the incision line is high and near the fold of the sulcus, an acrylic ball is attached to the screw pin to avoid unnecessary tissue reaction. The acrylic ball can be screwed up the pin as the tooth emerges so that it remains on the gum surface (*Figs.* 13, 14).

Orthodontic Treatment.—The canine is fairly resistant to movement and usually requires a fixed appliance with adequate anchorage spread round the arch. A large recess is bent into the palatal bow to allow for the rise of the palatal tissue over the buried tooth as it moves. A buccal bow is required to increase the anchorage and to prevent the reciprocal action from the spring from moving the incisors forwards.

There are many forms of spring which prove effective. A canine which requires only a simple tipping action involving a minimum amount of movement in the apical region will respond well to a stronger spring in 0·4-mm. or 0·5-mm. wire, provided that the spring has a wide range of movement. A tooth which is being drawn down through its axis must be moved more gently with a 0·3-mm. wire spring. Since the early stage of the treatment is the most precarious from the point of breakage, the canine is moved through the palate as quickly as possible. Where practical this movement is also made towards the correct position for the tooth in the arch. The pin attachment provides a simple and effective means of applying a controlled spring force to the buried tooth.

A film was then shown to demonstrate the surgical approach to the technique of exposing and pinning a canine tooth from the palatal and from the buccal approach.

Acknowledgements.—My thanks are due to Mr. K. Liddelow, Reader in Prosthetics, King's College Hospital, for his time and great skill in producing the films; to Miss Whiteley, of the Photographic Department, Guy's Hospital, and Mr. Smith, of King's College Hospital, for the photographs; and to Mr. Bailey, of the Chelsea Hospital for Women, for the drawings.

BIBLIOGRAPHY

Adamson, K. T. (1952), *Dent. J. Aust.*, **24**, 143.
Day, A. J. W. (1955), *Trans. B.S.S.O.*, 90.
Dewel, B. F. (1945), *Dent. Digest*, **51**, 492.
Fastlight, S. (1954), *Amer. J. Orthodont.*, **40**, 811.
Hartley, D. T. (1955), *Trans. B.S.S.O.*, 82.
Hitchin, A. D. (1951), *Dent. Practit.*, **2**, 100.
Lappin, M. M. (1951), *Amer. J. Orthodont.*, **37**, 749.
Shachter, H. (1951), *Trans. B.S.S.O.*, 76.
Watkin, H. G. (1947), *Ibid.*, 191.

DISCUSSION

The President congratulated Mr. Kettle on his paper. He said that it had been presented in an informal manner which gave him the impression that Mr. Kettle had spoken from considerable clinical experience. Mr. Kettle had covered the subject very fully indeed, and he had concluded with a very good film. Those who had assisted Mr. Kettle in producing the film were to be congratulated.

He called on Mr. Walpole Day to open the discussion.

Mr. Walpole Day said he wished to thank Mr. Kettle on two counts, first for a very interesting paper—he was sure that they had all enjoyed it very much indeed—and secondly for asking him to open the discussion.

As he saw it, they really had two problems with the impacted canine tooth—the empirical problem and the social or psychological problem.

To deal first with the empirical problem, when they had a patient with a misplaced tooth it presented them with a nice problem. They asked themselves how they got over the particular difficulty, and they thought of all the things that they had tried and considered what would work best in the case before them. Mr. Kettle had dealt fully with that problem.

The social or psychological problem was the problem of the person who was attached to the tooth. It was also the problem of the orthodontist. The orthodontist had to weigh up the possibilities and put them to the patient as to whether the tooth would be a useful one, whether it would be worth the trouble or not.

Among the main factors which might decide whether one tried to put a tooth straight or not was the time factor. One did not know how long it would take to put a tooth straight, but the more cases one did the better chance one had of being able to judge. In some cases that he had known the teeth had taken only a year; others had taken five or six years—although the fact that those had taken longer might be due to his technique being very different from that of Mr. Kettle.

One had to remember that in the case of older patients it almost invariably required the extraction of a premolar to make room, and one wondered sometimes whether that was justified.

Mr. Kettle had another problem. Having given a paper of that kind to the Society, one found not only that one had many cases of canine teeth thrust upon one but that one would be inundated with them. Some years ago he had presented a paper on a similar subject, and since then he had been flooded out with canine teeth cases and cases relating to other kinds of buried teeth. There came a time when one just had to draw the line and say that one could not treat all the cases. However, it might be that other orthodontists were not willing to treat them, and so one found as time went on that one tended to treat the easier cases, merely saying in respect of the more difficult ones: "That is all right, it should not give trouble. Leave it alone."; or: "That is in a difficult position; it may give trouble. Have it extracted."

One of Mr. Kettle's resorption cases was that of a pretty girl. Mr. Kettle had referred to the resorbed C's. However, he had observed from the film that there appeared to be two resorbed upper 4's as well. He considered that a very poor risk for any kind of orthodontic treatment.

With regard to empirical treatment, on one occasion he had shown a couple of cases in which he had used some kind of pinning technique, though not so elaborate as that used by Mr. Kettle. He almost blushed to mention that early paper of his, because it was very poor compared with Mr. Kettle's. One thing which could be said about it, however, was that twelve years had elapsed and a great deal of progress had been made—and that was very gratifying.

He had mentioned this matter about five years previously when another paper on the subject had been presented. His contribution had been at a demonstration meeting and subsequently written up for publication in the *Transactions*. It had been reprinted in a revised form by the *American Journal of Orthodontics*, and the comment had been made that the American orthodontists did not find it necessary to drill holes in teeth. He himself had drilled only two holes, and yet that was the comment that was made. He did not know what the American comment on Mr. Kettle's paper would be.

After reading that he had wondered whether there were other ways of doing it, and so he had experimented very fully. He had taken great care to see that the tip of the crown of the tooth was completely free of bone; otherwise the tooth did not seem to come down. He had experimented with the use of a packing of zinc oxide paste and cotton-wool and stitching the rest of the flap back, leaving a small window. He left the packing in for four, five, or six weeks, and if one did not put it in too tightly and left it alone it did not seem to cause any trouble. By the end of that time the tooth had usually erupted visibly, sometimes as much as $\frac{1}{8}$ in. or more in about six weeks. The packing was then removed and the wound left open. His practice was then to leave the teeth alone for twelve months or until he could get a spring to work on them. He had managed to bring down a number of canines without having to use a drill and put a pin in. There was the odd case where one could not use a drill and had to use a band.

It had been necessary to decline to do a number of such cases, because there were many cases to be dealt with, and it was possible to do five or six simple treatments in the time taken by a complicated one. However, the fascination of dealing with buried teeth was very great, and one found that one tended to think about the technique rather than what the patient might have to go through.

Using his technique, in which pins were not used, it meant a very much longer treatment from the time one exposed the tooth until the final result.

With regard to the technique of surgery, Mr. Kettle had said that he used a saline spray. Some of those present might not know what was meant by that. He presumed it was the same as he used. He had a little polythene tube leading from a spray bottle on the unit attached to the handpiece. The nurse or assistant pressed the valve on the spray bottle whilst the operator was drilling. It was very efficient.

Reference had been made to an enlarged tooth follicle on the teeth. He did not regard it as of importance. What was happening was that one was getting the follicle of the canine crown up against the X-ray film and thus getting a quite clear picture of it. He liked to see that enlarged follicle. It usually meant that the prognosis was very good, that the tooth was not deep, but was lying in the palate where it was easy to get at it.

Resorption of the laterals was a distressing feature. One came across it now and again. It appeared in the younger children, at the age of 11, 12, or 13 years, or even earlier. It seemed to him to be extremely rapid. One might take an X-ray picture and hardly see anything, and then a few months later the whole tip seemed to have disappeared. It was not always at the apex. It was sometimes at the apical third.

One often came across cases where it was said that a canine tooth was pressing against the incisors. He wondered whether it was not a fact that the lateral tooth being out of position allowed the canine to grow down into an abnormal position. In other words, it was

not the canine that was causing the lateral to be pushed out. Also, one somctimes saw canines apparently pushing the apices of thc incisors together. Should not this condition be regarded as merely gencral overcrowding rather than a local effect of canine pressure?

Mr. Kettle had shown an interesting slide illustrating the position of thc apex. On one side there was a normal canine and on the other the canine in the palate with the apex well back up to the incisor. It was the same as where a canine had erupted normally. He wondered whether the causc and effect were sometimes reversed in those cases.

He had been fascinated by Mr. Kettle's excellent paper, and also by the film.

The President said that Mr. Walpole Day had raised many of the points on which he had made notes.

One very important thing was that they must not be overwhelmed by their desire to make neat appliances. They must not forget the patient and what the patient had to go through. He would like to hear from someone in the near future an assessment of the real prognosis on a whole series of canines. He felt that in the past they had attempted too much and had put the patient through far too much. They would have saved a couple of years of hard orthodontic treatment if they had extracted the canine and put the first premolar in its place.

He agreed entirely with what Mr. Walpole Day had said, and he would suggest that Mr. Kettle was, in fact, confusing cause and effect, particularly in relation to the unequal resorption of deciduous canine roots. He believed that the uneven resorption was due to the fact that the canine was already displaced. In cases which looked exactly like some of Mr. Kettle's from the intra-oral film, it was his practice to leave the deciduous canine entirely aloue He believed that it maintained alveolar bone through which the permanent canine would move into place. In other words, this result of inactivity demonstrated that it was not the deciduous canine which had caused a displacement of the permanent canine. It was the displacement of the permanent canine which had caused unequal resorption of the deciduous tooth.

Mr. Kettle had shown a rather large flap for exposure of the canine for the insertion of a hook. He presumed that if Mr. Kettle was merely going to expose the eanine and then leave it exposed with a pack, he would not use a flap of that dimension. Also, he would like Mr. Kettle to tell him more clearly how he made certain that he inserted the hook without damaging the pulp. He had to admit that he would be frightened to go into a canine as Mr. Kettle had shown in the film.

Mr. J. E. Phillips said he had not had much experience of treating the sort of condition in question, but he had three slides showing X-ray films which he had taken of a child with that condition. He had taken out the deciduous canine and the premolar, and had been intending to do something about bringing down the permanent canine. However, the child had not been brought into him for about eighteen months, until the previous Saturday when she had visited him, and he had then found that the canine was now in practically a normal position.

The first slide showed the first picture that he had taken. The canine was lying palatal to the other teeth.

The second slide showed that the tooth had turned a complete half-turn.

The third slidc showed the canine in a better position still. It had now fully erupted, a little in-standing to the lateral, but was in a very good position. It just wanted a little pressure on the anterior surface to push it into the arch.

Mr. R. T. Broadway said he was very pleased that Mr. Kettle had told them of all the difficulties that one might encounter in exposing canines and bringing them down into position.

When Mr. Kettle pushed the crown of the canine out from the palate, had he not found that the apex had tended to move in palatally, resulting in the final appearance of the canine looking buccally, so that torque was rcquired on the canine to bring the root out again? He had been through a number of cases at the Eastman Dental Hospital and had found a number of cases where the canine had been pushed out of the palate and the apex had tended to go palatally, and it had required torquing out to get it into a decent position. He wondered whether that had been Mr. Kettle's experience.

Mr. J. S. Beresford said that whenever Mr. Kettle spoke to them they knew that they were in for something good. The size of the meeting testified to that. He had enjoyed Mr. Kettle's paper very much. Mr. Kettle had gone into the subject very thoroughly and had thrashed out most of the points.

He would try not to ask questions, and then Mr. Kettle could please himself whether he commented or not.

With regard to the palpation of canines, he had palpated one in the palate on one occasion, and because he was surrounded by students he had had an X ray taken, and the canine happened to be labial and what he had palpated was a cyst.

He had a hunch that the misplaced canines might be of a hereditary nature. Perhaps that was something which they might look out for.

He had the idea that cysts were the effect of an unerupted canine rather than the cause, but he might be wrong.

With regard to the extraction of premolars, sometimes the extraction of the second rather than the first premolars saved the risk of an embarrassing space too near the front.

In respect of one slide, Mr. Kettle had said that the deciduous canine had not resorbed. The E was still present. Perhaps Mr. Kettle had been looking for rcsorption a little soon.

He had lost the art of drilling into teeth and had never had any art in surgery. So he had always been reluctant about drilling into teeth. If a pin was put into a tooth, it must be done properly and perfectly by someone used to drilling into teeth and skilled in conservative work. Mr. Kettle had shown them the answer to that. He was full of admiration for Mr. Kettle's pins, for they were very good.

Generally, because of his difficulties in that direction, he had tried to work without pins, rcsorting to the waiting technique which Mr. Walpole Day had mentioned.

Some of the surgeons who had uncovered teeth for him had held their packs in by means of a celluloid crown form.

He noticed that Mr. Kettle had his apparatus ready before the canine was uncovered. Although Mr. Kettle had not said so, that was important. The apparatus should be ready before the surgery was performed and thc arch could thcn be snapped into place.

Mr. Kettle had mentioned a difficulty with springs engaging unerupted teeth in the absence of hooks. For some reason which he could not explain, if one used

a platinum-gold arch and spring one got something which was lacking with a stainless-steel spring.

The President said that Mr. Beresford had reminded him that he had wanted to congratulate Mr. Kettle on his clinical examinations. One tended these days to request large numbers of X-ray films, regardless of cost, and before making a proper clinical examination.

Mr. N. Gray thanked Mr. Kettle for a very stimulating and interesting paper.

What Mr. Kettle had said about palpating the canines of young children of 9, 10, and 11 years was a most valuable contribution to diagnosis that was often overlooked. It was a good routine for the orthodontist to feel round the patient's mouth for the presence of unerupted teeth.

He wished to utter a note of warning about the pinning of teeth. He had seen two pulps die, and it was unpleasant when that happened in a buried tooth. It very often meant the ultimate sacrifice of the canine.

If one fitted a lingual arch before the exposure of the unerupted tooth and packed the flap with zinc oxide paste and cotton-wool, and then tucked part of the dressing under the appliance, it helped in the retention of the dressing. One could also use the dressing for directing the unerupted tooth by pressure on the crown. If one wanted to move it labially one packed it lingually. It acted as an appliance itself.

By means of a banded tooth with a Townend channel one could get a much better pull. A banded tooth seemed to him to be very much safer than pinning, which had the possible disadvantage of killing the pulp and of staining the tooth.

Mr. Kettle, in replying to the discussion, thanked Mr. Walpole Day for opening the discussion and raising one or two points. Mr. Walpole Day had quite correctly observed the resorption of two upper first premolars in one case. The saline spray was attached to the handpiece. It sprayed under very good control a jet into the area of operation. It was of very great value in improving visibility and in the control of local hæmorrhage.

He thanked Professor Ballard for his remarks. It was extremely important to try to assess the value of the canine to the patient. If one could find a way of disposing of the canine, that was to him the most sensible course to take, but unfortunately it was rarely possible. With regard to the subject of cause and effect in the position of an impacted upper canine he was not certain, with great respect to the President, that the observations which had been made coincided with his own findings.

It was for safety first that he cut a large flap in the palate for the exposure of the canine. The cases in which he had trouble with hæmorrhage and the cases in which he had seen others in trouble with hæmorrhage had always been due to little untidy flaps which had not been under proper control. In such cases the burr could slip into the flap. Simple exposure of a tooth to aid its eruption did not require a flap of the size he had shown, for one was merely making an exit hole over the tooth.

Reference had been made to inserting a pin into a tooth without damaging the pulp. The best thing to do was to get hold of a few extracted teeth and practise on them.

He thanked Mr. Phillips for his remarks. He was very interested in the case mentioned. It was similar to the one he had shown in which the first upper premolars and temporary canines were removed. The temporary upper canines appear to hold the key to the situation. He had found in many cases that the extraction of the temporary canines, as opposed to the first premolars, brought an immediate response from the buried tooth.

Mr. Broadway, for whose remarks he was grateful, had mentioned another important point. A canine lying in the palate has its apex displaced outwards. An outward movement of the crown would cause an inward movement of the apex. The bulk of the movement would be in the crown of the tooth and the lesser movement would be in the apex. If one used powerful appliances fixed firmly to the impacted tooth and not gentle springs with a loose attachment to the tooth, there was more chance of bringing about exaggerated movement of the apex.

Mr. Beresford had made reference to palpation. If the tooth was lying on the buccal side and he had observed the position of the lateral incisor, it would have been seen to have its apex displaced inwards and its crown tipped forwards. He never relied on one item of information but tried to consider all the relevant pieces of information to come to a decision. The second premolar was not a reliable tooth to extract because of the close relationship between the canine and the first premolar.

Reference had been made to celluloid crown forms. Many of the teeth were in such a difficult position that it was out of the question to put crown forms on them or band them. They had to be disimpacted away from the incisors before they could be moved into position. It was a good thing to have the apparatus ready to put into place, because the bands could be put on and the palate could be closed up, making it much more comfortable for the patient.

He had been interested to hear from Mr. Gray that he had had some teeth die under the influence of pins. So far he had not had one case. He felt that Mr. Gray must have been very close to the pulp. He did not think that the actual pinning operation itself would have led to pulp death. No difficulty had been encountered in tooth stain, but only oxyphosphate cement was used to fix the pin.

The President, in proposing a hearty vote of thanks to both Mr. Kettle and Mr. Walpole Day, said that those present would agree that it had been a most exhaustive treatment of the subject. He thought that when it was printed it would probably be the best paper to date.

The vote of thanks was carried by acclamation, and the meeting then terminated.

GROWTH AND THE PREDICTION OF ABNORMALITY

By J. M. TANNER, M.D., D.Sc., D.P.M.

It is a great honour for a research worker in the basic sciences of anatomy and physiology to be asked to give this Northcroft lecture, and accordingly I have spent much time wondering in just what way anything I say can contribute to the advance of orthodontics. I have no practical experience and little theoretical knowledge of orthodontics. My chief concern over the last few years has been with the growth of perfectly normal children, children who present no particular problems either in their dental or in their general physical development. I do not even have any special knowledge of the growth of the face and teeth; there are certainly many of you here who could discuss that subject much more adequately than I.

But it is very typical of orthodontists all the world over that it should be they, and not the pædiatrician or the orthopædist, or the child psychiatrist, who invite a lecturer from the basic growth and development field. For twenty years now our major support from the clinical side has been from orthodontists, both here and in America. Orthodontists, above all other clinicians, have felt the necessity for a thorough knowledge of the normal growth processes as a basis for a decision to interfere or not to interfere with the course of events in a given child. Perhaps one of the reasons for this is that orthodontists deal for the most part with normal extreme variants rather than with distinctly pathological cases. The only medical specialists of whom this is also partly true are (in this country) the ophthalmologists—though their weapons are much less powerful than yours. The great majority of refraction errors arise as normal variations in co-ordination of the growth pattern of lens and anterior chamber, while only a few, comprising most of the very extreme myopes, have a different single, interfering factor as a cause and are hence called truly pathological (Sorsby, Benjamin, Davey, Sheridan, and Tanner, 1957). I imagine much the same may be said of the commoner conditions that you are called upon to treat.

Not all your patients, however, will receive treatment. Many will be left alone with reassurance to the parent that the problem will solve itself as growth of the face proceeds. Such reassurance can only be given on the basis of accurate knowledge of future events, that is of accurate prediction of the growth curves of the child in question. Prediction of future growth becomes a matter of great importance.

Accordingly, I am going to devote the first part of this lecture to discussing the method by which prediction of a given dimension at age 8, say, may be best made from knowledge of the dimension at age 4. I shall then present some practical results recently obtained in my laboratory on the degree to which adult dimensions may be predicted from measurements taken in the first five years of life. Later I shall go on to talk about the more complicated problem of predieting co-ordinated growth, that is, change of *shape*, using more than a single dimension; and lastly, I shall discuss the use and abuse of standards, explicitly of height and weight for age but implicitly of all other body or face dimensions, too.

THE PREDICTION OF SIZE AT A GIVEN AGE FROM SIZE AT A PREVIOUS AGE

Suppose the orthodontist sees a child, aged 4, and notes that he has relatively broad maxillary and mandibular arches. He wishes to know what will be the state of these arches at age 8, say, and he hazards the clinical opinion that they will probably be relatively broad then, too. His opinion is entirely correct, but it lacks precision; the snag lies in the "probably". Is there no way by which we can reach some more precise statement such

The Eleventh Northcroft Memorial Lecture given at the Meeting on December 16, 1957.

as, for example: "50 per cent of children with arches this broad by 8 years old lie in the top quarter for breadth of all children—30 per cent lie in the second quarter, 20 per cent in the third quarter. Therefore, the chances are good that this boy's arches will remain wider than average, but a one-in-five chance does exist of the arches being less than average."

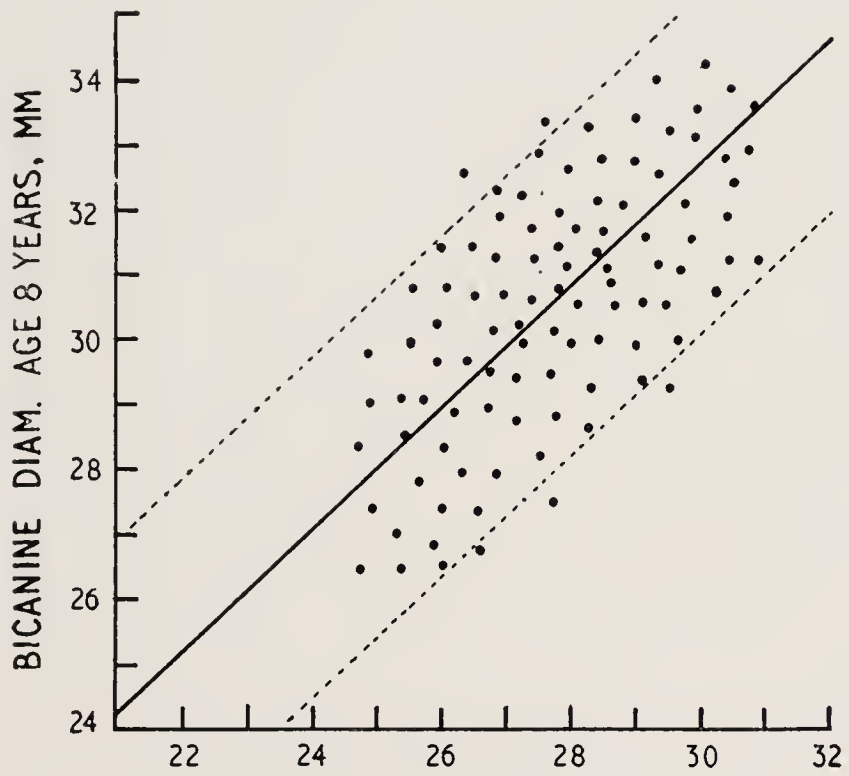


Fig. 1.—To show prediction of an anthropometric dimension at later age from same dimension at earlier age. Points plotted are diagrammatic only: regression line from data of Holcomb and Meredith (1956).

Such a statement can be made, and results from the application of a few simple statistical methods. First, we must, of course, have made a study of dental arch widths of children wherein each child was followed from age 4 to age 8. This is what is known as a longitudinal study—one wherein the *same* children are measured in successive years—as opposed to a cross-sectional study, wherein *different* groups of children are measured at ages 4, 5, 6, etc. Longitudinal studies take longer than cross-sectional ones, are more expensive, and demand much patience from the researchers and their administrative supporters, but they are absolutely essential to the understanding of the growth process and for practical purposes, too, as you see from the example I am giving you. Such a study has in fact been made at the University of Iowa by Holcomb and Meredith (1956), who measured 50 boys and 50 girls each year from age 4 to age 8.

The measurement we are considering is the maximum width from the outside surface of one canine to the outside surface of the other. The first step is to plot the bicanine width at 8 years along the Y axis, against the bicanine width at 4 years along the X axis, for each individual. A straight line can then be drawn through these points, but of course the points will not all be along the line but will scatter to either side of it (*Fig.* 1). The line is known as the *regression* line and its equation, $y=a+bx$, or, in this instance,

Bicanine diameter age 8 (mm.) $=4{\cdot}6+0{\cdot}94$ Bicanine diameter age 4 (mm.)
[mandibular, male]

gives the best prediction of age-8 status from age-4 status that can be made on the present data. If we use this equation to predict the 8-year width of a group of boys, however, how often will our results be accurate and how often will they be considerably wide of the mark? The statistic which answers this question is the *correlation coefficient.* (Methods for calculating the regression line and the correlation coefficient, etc., are given in all standard text-books; briefly, they involve using all the original measurements and their squares.) The correlation coefficient measures the degree to which the 4-year and 8-year measurements are associated, the degree of predictability of one from another. The coefficient varies from 0, which indicates that the two measurements in question are totally independent one of another, to 1, which indicates total dependence one on another. In this instance the correlation coefficient is 0·80, a fairly high figure.

Knowing this, and knowing the *standard deviation* (a measure of the scatter around the average) of the measurements at 8 years (1·59 mm.), we can calculate the statistic we are chiefly in need of: the *standard error of estimate*, as

$$1{\cdot}59\sqrt{1-0{\cdot}80^2}=1{\cdot}59\times0{\cdot}6=0{\cdot}96 \text{ mm.}$$

This tells us that when we predict the 8-year measurement from the 4-year one, we shall in approximately two-thirds of all cases be within 0·96 mm. of the actual measurement,

and in 95 per cent of cases be within $2 \times 0{\cdot}96 = 1{\cdot}92$ mm. of the actual measurement. We have thus achieved the extra accuracy that we wanted over the purely inspectional or clinical statement. Perhaps our decision to undertake a certain treatment depends on whether we can reasonably expect this particular arch, now at age 4 years 25 mm. wide, to achieve an 8-year-old width of 30 mm. From our equation we see that our prediction of the most likely 8-year width would be $3{\cdot}9 + 0{\cdot}96 \times 25 = 28{\cdot}0$ mm. There is a 33 per cent chance that this boy's arch might reach 28·96 or roughly 29 mm., and a 2·5 per cent chance it might reach 30 mm. We would then act accordingly.

The precision here is such as is seldom needed in clinical medicine: but in orthodontics it may well be. The moral of this story seems to be: (1) Simple statistical methods are useful tools; (2) Longitudinal studies of healthy children as well as of orthodontic problem children are essential and should be supported.

THE PREDICTION OF ADULT SIZE FROM SIZE DURING THE FIRST FIVE YEARS

I now want to interject some recent results on the predictability of the *adult* dimensions from dimensions in the first 5 years of life. This work, which was done in collaboration with Professor Lockhart and Dr. McKenzie of Aberdeen, Mr. Healy of Rothamsted Experimental Station, and Mr. Whitehouse of the Harpenden Growth Study, has been given in detail elsewhere (Tanner, Healy, Lockhart, McKenzie, and Whitehouse, 1956), and I shall only call your attention to the most salient points. Some twenty-five years ago Professor Alexander Low of the Department of Anatomy, Marishal College, Aberdeen, took a series of measurements including head length and breadth on a number of children at birth, and on every subsequent birthday up to and including the fifth. We were able to trace and re-measure 65 per cent of these people between 20 and 25 years later, so that we had measurements on a total of 55 men and 65 women at maturity, that is between age 26 and 30. We then calculated the correlation coefficients for each measurement between the values at birth and at adulthood, 1 year and adulthood, 2 years and adulthood, etc. The correlation coefficients are displayed in *Fig.* 2. Looking first at the top line, that is, supine length, we see that the correlation between birth length and adult length is quite small, being about 0·28. (The illustration shows the average of the male and female correlations.) By 1 year old,

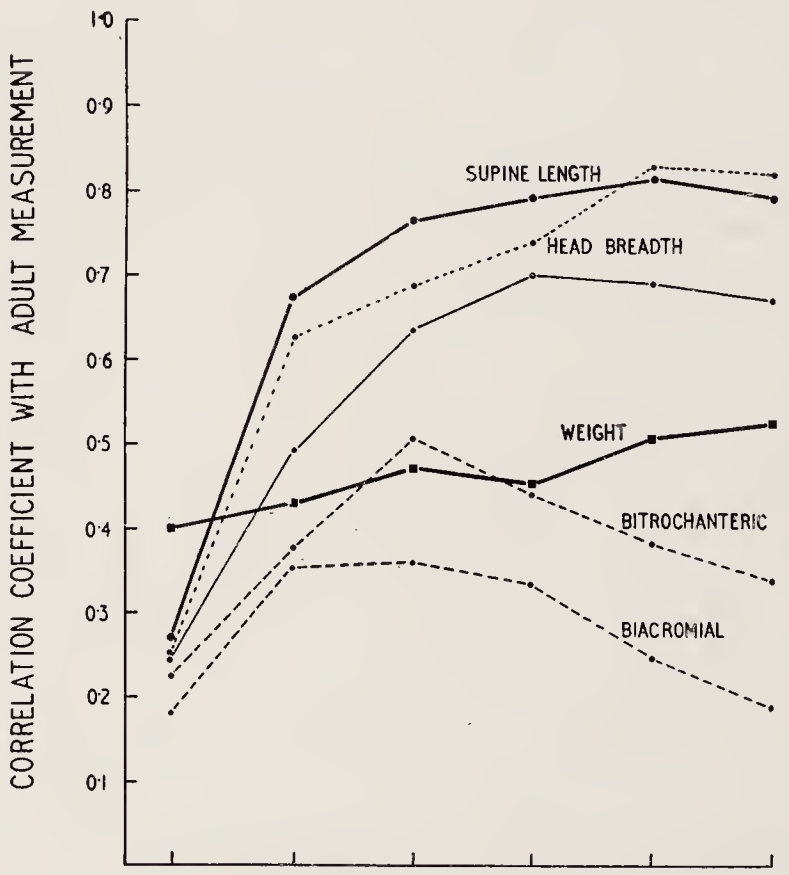


Fig. 2.—Correlation of adult anthropometric dimension with same dimension measured at birth and 1, 2, 3, 4, and 5 years. (*From Tanner and others*, (1956), *Arch. Dis. Childh.*, **31**, 372.)

however, the correlation has risen drastically and now approaches 0·7. By 2 years old it is still higher, and there is a further small increase to 3 years old, at which time the correlation is approximately 0·8. Little further increase occurs up to 5 years in this data, and by reference to some other data in the literature, right up to puberty.

You will see that the next line down is that for head breadth, which follows a very similar pattern indeed to that of supine length. Head length is not plotted here, but produces also a similarly shaped curve, though the actual correlations are at most ages slightly below those given for head breadth. The measurement called cubit is of forearm plus hand length, and this also follows the same general

curve. Body-weight, on the other hand, has a slightly larger correlation than most other measurements at birth, but the correlations increase less than for the other measurements, so that prediction of adult weight from weight at 5 years is very much worse than prediction of adult height from height at 5 years.

The main point of interest about these results is the lack of relationship between measurements taken at birth and measurements taken subsequently. Not only are predictions of adult size surprisingly poor if made from measurements at birth, but even prediction of size at one year from size at birth is not very good. It seems that birth represents something of a disturbance in the smooth unfolding of growth. There is other evidence that genetically large fœtuses in small mothers grow particularly slowly during the last intrauterine months, and also are expelled somewhat earlier than large fœtuses growing in large mothers. It takes a little time for these restrained fœtuses to get back on to their presumably genetically determined curves of growth, but it appears that they do get back to it under normal nutritional circumstances by about 6 or 9 months post-partum, and this is very likely the reason why the correlations have risen so sharply by one year.

I doubt if the curves in *Fig.* 2 have any immediate interest for orthodontic practice, but I do not doubt for a minute that similar curves, constructed for various dimensions of the face and head from 1 or 2 years onwards, would be of great interest and of great practical use to many of you. At present we lack such curves entirely.

It is most unfortunate that these Aberdeen measurements cease at 5 years, but some data from other growth studies show that for height at least there is little increase in the correlation with adult value from 5 onwards. It seems that the correlation stays at about 0·8 up to puberty. Then, after a drop at puberty due to time-spreading effect of different individuals having their adolescent spurt at different periods, it rises to near unity as growth ceases (Tanner, 1951).

It seems that the magnitude of the adolescent growth spurt may be to some extent independent of the magnitude of growth previously. This independence may be of more importance in the endeavour to predict adult stature correctly than it is in the prediction of facial changes in relation to orthodontics. An adolescent spurt does, of course, occur in most facial measurements, and is largest in the mandible, which lags behind the rest of the face in its development and is therefore growing fastest, and presumably on that account responding most, at adolescence. Between 12 and 20 years, about 6 per cent of growth remains to be completed in the cranial base, but in boys nearer 25 per cent in the ramus height of the mandible (Tanner, 1955). It is particularly in order to cope with this adolescent spurt independence that Björk (1955) and others have studied facial changes at adolescence, endeavouring to relate them to the general physique of the child in order that we may make better predictions as to what is liable to appear at this time in children of various body builds.

GROWTH IN PATTERN

The next problem which confronts us, which is at the same time more interesting to the research worker and of more practical value to the clinician, is that of *co-ordinated* growth, or as it is sometimes called, relative growth: growth of one measurement relative to other measurements, growth in *pattern*. The interest in this to the research worker lies in the fact that he does not as yet really understand how to deal with it; we are now right at the edge of the research front.

I do not want to plunge you into the intricacies of a highly technical subject, and in any case, there is no time to do so. But I do want to indicate the lines along which the problems of change in *form* are being tackled.

One of the first approaches was the comparison of the rates of growth of two dimensions by a simple ratio. If a cm./year was the rate of dimension A, and b cm./year the rate of B, then the ratio a/b tells us something about how much faster A is growing than B (cf. mandible and maxilla widths at adolescence, etc.). Julian Huxley's "relative growth" approach is fundamentally this, but in terms of the logs

of the dimensions; his equation $l = bm^k$ reduces to

$$\frac{\text{rate of change of log } l}{\text{rate of change of log } m} = k$$

Though originally Huxley's formulation postulated that k was constant over prolonged periods of time, it is now generally realized that this was an oversimplification and that k,

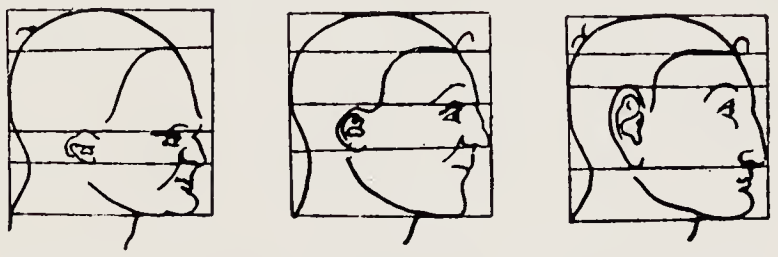


Fig. 3.—To show application of method of transformed co-ordinates. (*From D. W. Thompson* (1942), *On Growth and Form*, 2nd edn. Cambridge.)

at least in mammals, describes a continuously varying curve with time, the type of curve depending on what two dimensions are being compared (Tanner, 1951).

This formulation by ratio, whether straight or logarithmic, suffers from the disadvantage that only two dimensions can be handled at one time. I suspect this simple fact is partly responsible for the disputes over exactly what two measurements to compare when analysing lateral skull radiographs, the problem of what dimension to take as a "base-line". A more logical, as well as more comprehensive, approach is not to elevate any one particular measurement to base-line status but to study simultaneously the whole change in form as represented by some dozen or more measurements in serial radiographs. In this way areas where growth rates are large may show up and the distribution of growth gradient fields may become manifest.

D'Arcy Thompson (1942) was the first to suggest this way of analysing form change in his famous book *On Growth and Form*. His method, called the "method of co-ordinate transformation", was purely graphical (*Figs.* 3 and 4). However, it can be made fully analytic, in the algebraical sense, as Richards and Kavanagh (1945), Medawar (1945), and others have shown. The mathematics of this approach are not too simple, but I believe the approach itself is eminently suited to the analysis of changes in the skull and face. I much hope someone with a longitudinal series of skull radiographs in his files will try his hand at it. The ultimate usefulness of the method in analysing shape change in various orthodontic conditions will depend on whether it will convert for us a complicated change of shape into a product of simpler transformations, each term of which represents the action

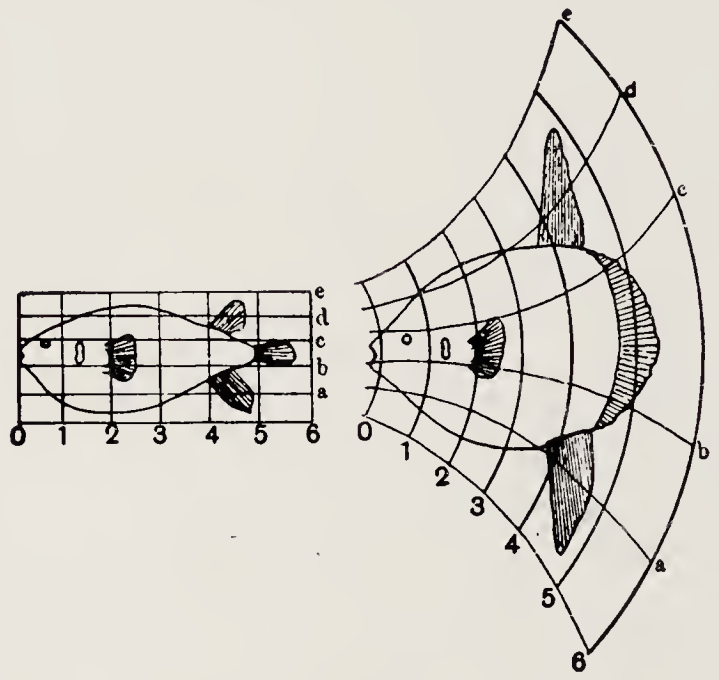


Fig. 4.—To show application of method of transformed co-ordinates. (*From D. W. Thompson* (1942), *On Growth and Form*, 2nd edn. Cambridge.)

of a distinct morphogenetic stimulus. (To paraphrase Medawar (1945). This is the same criterion as that invoked in the reification of factors of a factor analysis (Tanner, 1947).) I have hopes that it really would do so.

THE USE OF STANDARDS

I want now to return for the last portion of this lecture to much simpler considerations, the A, so to speak, of the series of which we have just been considering somewhere around the F. One method of seeing whether a child is growing properly is to plot each of his dimensions in relation to so-called standards for that dimension, that is, in relation to measurements obtained from a group of normal children of the same age. Such a practice, with reference to height and weight, is the standard way of following the growth of the child in baby clinics, school medical services, medical practice, and the home. I shall confine my discussion to height and weight standards, since it will be a discussion of principles which you can translate

readily in their application to growth of facial dimensions.

In the construction of "distance" standards, that is, standards of height or weight achieved at any given age, a cross-sectional study is all that is needed. The most important thing is to obtain an adequate sample of the population

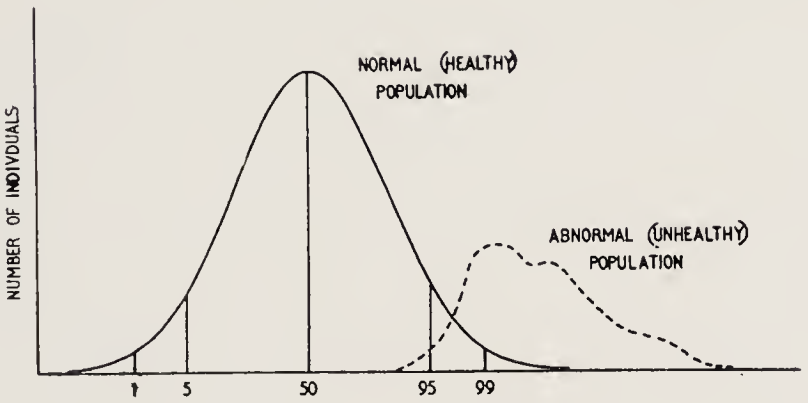


Fig. 5.—Possible overlap of healthy and unhealthy populations (hypothetical). (*From Tanner* (1952), *Arch. Dis. Childh.*, **27**, 10.)

of children that the standards are going to apply to, and by adequate I mean not only one sufficiently large in numbers, but one sampling in correct proportion the various social classes, economic strata, geographical sites, and so on. It may astonish you to learn that due to lack of suitable samples it is only very recently that the first reasonably accurate standards for height and weight of British children from birth to maturity have appeared (Tanner, 1958). I do not believe that as yet any suitable data for constructing standards in relation to orthodontic practice are available, and it would seem to me that a survey to obtain them would be a very worthwhile proceeding.

The Meaning of Abnormal.—Before these standards are used one has to have some idea of what one means by the term "abnormal". Just exactly how does a standard tell you whether a child is abnormally, let us say, tall, or not? This is a matter about which some confusion tends to exist, and I think it would be as well if I outline one, though not the only, meaning of "abnormal."

Consider a population of healthy children all of the same age. Measure their heights and plot their frequency distribution; you will obtain a Gaussian curve, like that illustrated in *Fig.* 5. Now suppose we have a second group of children with acidophil adenomata of the pituitary, mid-brain tumours, and so forth. This is the abnormal population, and on average its members will be taller than the members of the normal population. Possibly, however, the two populations overlap in their distribution and we get the situation illustrated in the figure. Now suppose we have a child M whose stature lies at the 99th percentile of the normal Gaussian curve. Since the populations overlap in this region it is not possible to say with certainty whether M belongs to one or to the other. All we can state is the probability of his belonging to one or the other, and this probability we can state precisely if we know the distributions of the two populations.

We usually do not know in practice the distribution of the unhealthy population, and so we lay down arbitrary "limits of normality". The essential thing is to recognize that these limits are arbitrary and understand what they imply. If we take the stand that anybody over the 95th percentile shall be called abnormally tall, then we shall pick out of a mixed group perhaps most of the actually abnormally tall children, but only at the expense of including in this category 5 out of every 100 normal children. If we adopt the 99th percentile as the limit, then we shall pick up fewer real abnormals, but we shall only call 1 normal person in every 100 abnormal. The limits of normality that we adopt must obviously depend on the use to which they are going to be put. If the result of being classified as abnormal is an immediate and serious operation, we should have to put the limit at the 99th percentile or beyond to ensure that we operated on very few normals, but if the result of being classified as abnormal is a holiday at the seaside or extra milk in the mornings, then our limits could be much lower, perhaps at the 80th, or its lower equivalent, the 20th, percentile.

There is, of course, as I hinted in my opening remarks, another way in which the word "abnormal" may be used, merely to mean those children who are (to continue for the moment in relation to height) so tall that they offend the æsthetic sense and are socially handicapped by bumping into rafters, doorways, etc. Their

size, however, is their natural size, that is the height they achieve by reason of their genetic potentialities, and in no way implies that they have some pathological process, whether genetic or otherwise, going on inside them. I suspect that this use of the word "abnormal" is that which is most common in orthodontic practice, and also in ophthalmology. I do not know, though most of you here could tell me, whether the average case of a postnormal mandible (Angle II) is dependent on some distinct pathological process; I rather presume not. If I am right in this assumption, then when you strive to detect and correct such a case you are not in the position of the pædiatrician who wonders whether he should explore M's pituitary for a tumour because M is so very tall, but in the position of a pædiatrician who gives massive doses of œstrogen to a girl of 5 ft. 9 in. at age 10 whose predicted adult height will be 6 ft. 2 in. To date, probably only in orthodontics and ophthalmology has any serious effort been made to correct towards æsthetic and practical ideals deviations which carry social and practical awkwardness. Such a practice, though obviously justifiable in these two specialities, would raise some very awkward questions if applied in pædiatrics generally. I do not want to discuss these questions now; all I wish to point out is that we shall not be able to discuss them clearly unless we recognize the two ways in which this word "abnormal" may be used.

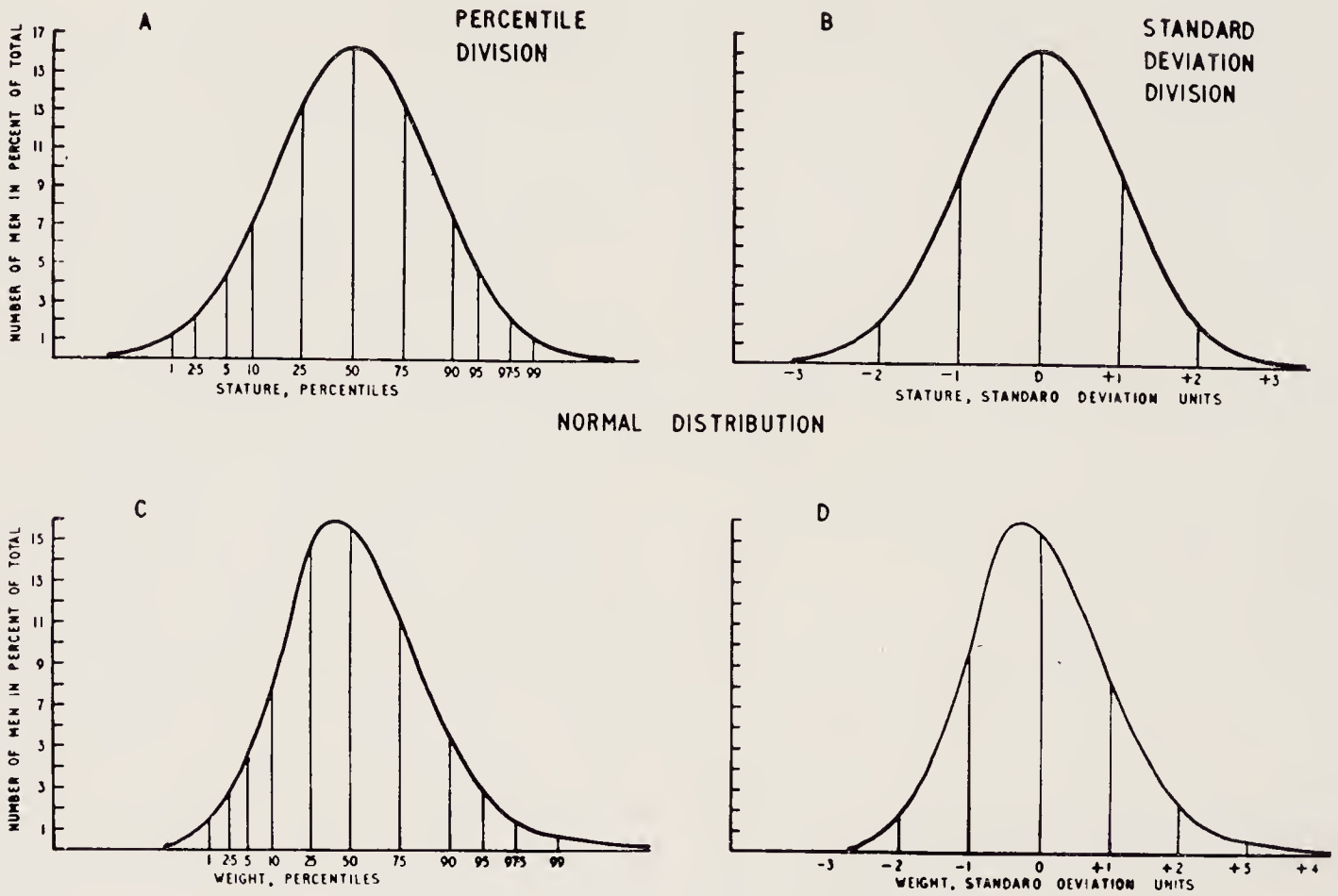


Fig. 6.—To illustrate the relation of percentile and standard deviation divisions of: A, B, a population with Gaussian distribution, C, D, a peaked and positively skewed distribution. (*From Tanner* (1952), *Arch. Dis. Childh.*, **27**, 10.)

Percentiles versus Standard Deviations.—Our height and weight standards employ either a division into percentiles or else a division into standard deviations (*Fig.* 6). The percentile division speaks for itself; if a child's height places him in the 50th percentile for his group, this means that 50 per cent of the children of the same age are taller and 50 per cent shorter than he. If he is at the 95th percentile, this means that 5 per cent of the children are taller and 95 per cent shorter. It is this position relative to the standardizing group that we always wish to know, but for technical reasons that we need not now go into, the standard charts often give standard deviations instead of percentiles. If, and only if, the distribution of the measuremcnts is Gaussian, as it is with stature but not with weight, then

very direct translations may be made from s.d's into percentiles, +0·67 s.d. corresponding to the 75th percentile, +1·65 s.d. to the 95th percentile, +2 s.d. to the 97·5th percentile, +2·3 s.d. to the 99th percentile, and symmetrically for the minus s.d's. Probably the

These standards, which are essentially height-achieved ones, are often used for plotting the actual growth of a child from year to year, as in *Fig.* 7 A. This procedure can lead one into difficulties. As a general rule, a child is likely to remain at around the same

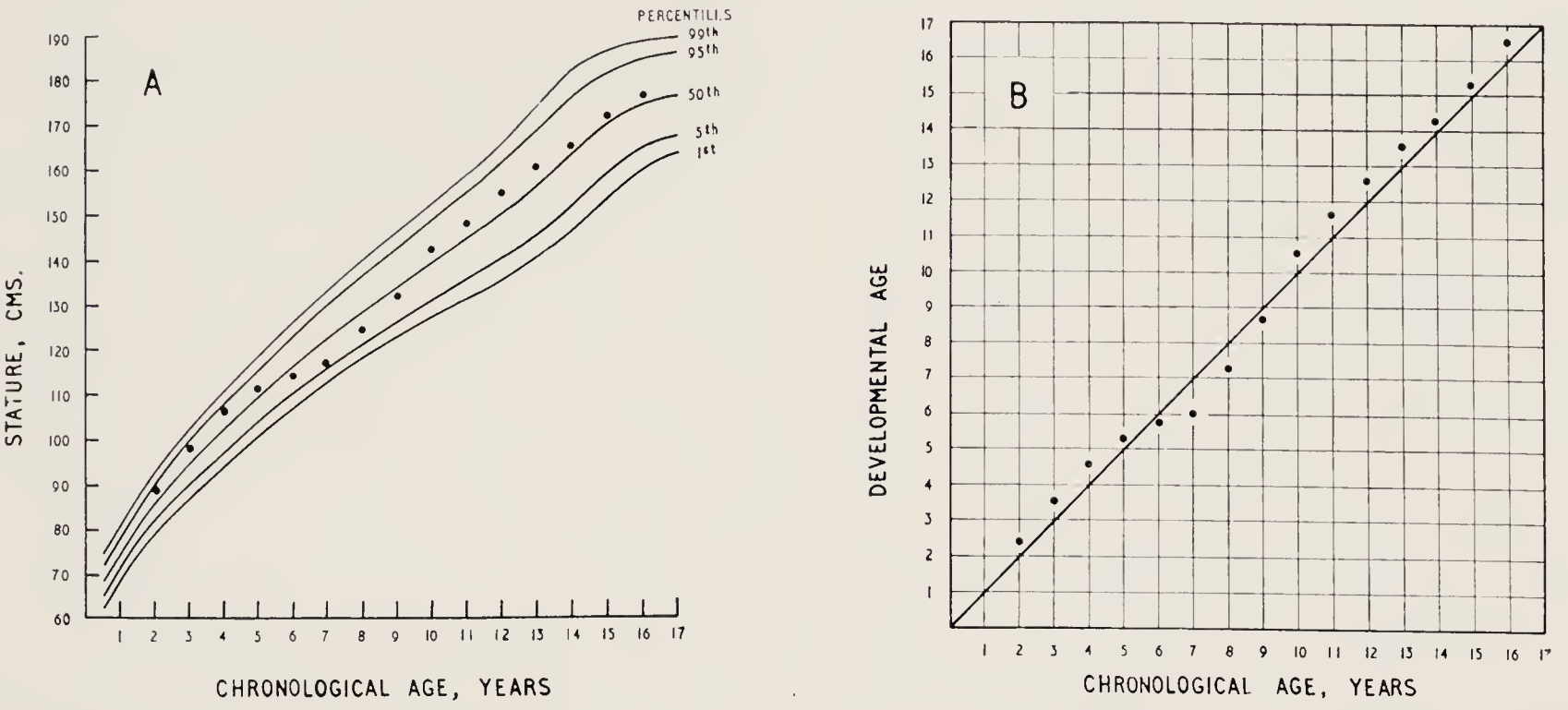


Fig. 7.—Growth of hypothetical child with retardation from age 5 to 7 years. Note that neither method A nor B gives test for abnormality of velocity. (*From Tanner* (1952), *Arch. Dis. Childh.*, **27**, 10.)

distributions of most facial measurements are in fact Gaussian, and so this translation would apply directly. But as you can see from charts C and D in *Fig.* 6, in a skewed distribution, such as weight, the percentiles do not correspond in this way to the s.d's. In fact, the s.d. for this sort of distribution is a much less informative statistic than it is for a Gaussian distribution. Thus, standards for weight have either to be presented directly as percentiles or else some transformation of weight has to be given which will convert it into a Gaussian distribution.

Distance versus Velocity Standards.—The usual standard chart plots a series of percentiles, for example, for stature against increasing chronological age; the percentiles normally given are 3rd, 10th, 25th, 50th, 75th, 90th, and 97th. The idea is that if a child falls outside the 10th to 90th limits the physician is alerted to the possibility of abnormality, and that if the child further lies outside the 3rd to 97th percentiles he is considered and investigated as abnormal until proven otherwise.

percentile level throughout his growth, except at adolescence, where if he is an early maturer his spurt will carry him up towards the top percentile and then drop him towards his original level, or if he is a late maturer will drop him down to a low percentile before he recovers to the original level. But since velocity of growth is to a very large extent independent of size achieved, some children will decrease in percentile status regularly throughout the course of their growth, and others will increase, and there is nothing whatever abnormal in this. The converse may also occur, as illustrated in *Fig.* 7 A. A child at the 95th percentile here has an illness which brings him down to the 5th percentile, and later picks up to about the 60th. Conventionally and "cross-sectionally" considered, this child would at no time be under normal stature, yet it is clear that the rate of growth from 4 to 7 years was abnormally low. It is for this reason that I think we should use standards for velocity as well as standards for distance, if we wish to detect abnormality of growth as early as possible. The necessary data

for velocity standards do not yet exist in this country. I would imagine that, particularly in relation to facial growth where you are concerned with relatively small deviations from average, velocity standards would have advantages over distance ones.

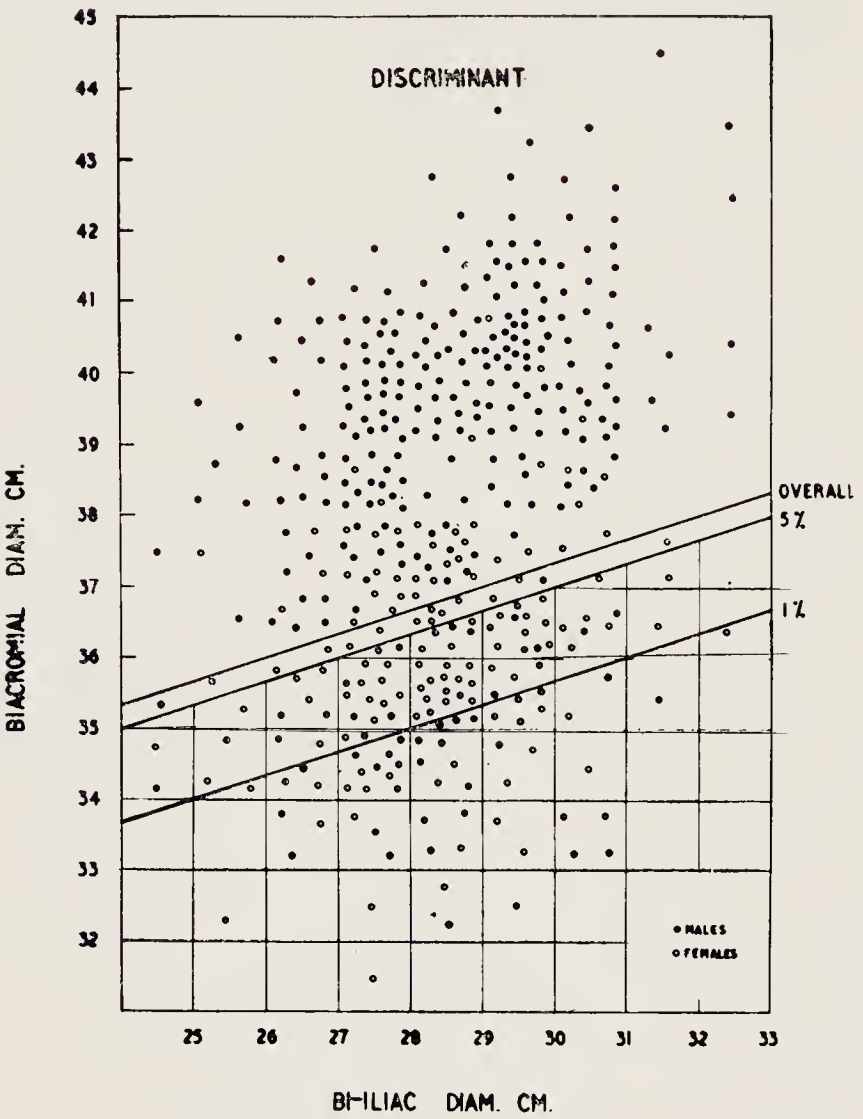


Fig. 8.—Construction of a discriminant function. Line "overall" gives best separation of males and females possible by reference to these two measurements; 5 per cent misclassifies 5 per cent of males; 1 per cent misclassifies 1 per cent of males. (*From Tanner* (1952), *Arch. Dis. Childh.*, **27**, 10.)

Multiple Measurement Standards.—Lastly, I should at least indicate the next more complicated phase of the use of standards. We have only discussed so far the use of a single measurement for detecting abnormality. It is obvious that really a finer detection could be made by the use of multiple measurements, but we have not discussed how the results of several measurements should be related together to give us an overall diagnosis. But if a child's scores, say on seven measurements, are six 75th percentiles and one 97th percentile, what are we to say? Again, if we had two children of the same age, one at the 95th percentile for height and weight and hip width, and the other at the 95th percentile for height and hip width but the 5th percentile for weight, we would come to radically different opinions about the two. The former is quite simply a large child, the latter a child with a large skeleton and a probably abnormally small amount of muscle or fat, or both. Clearly the relationship between two or more measurements gives us added information about the child, and this information we have so far neglected.

I have no time now to make more than the rather ominous remark that as soon as two measurements instead of one are taken, the situation becomes a good deal more complex than is generally realized. The complexity fundamentally arises out of the fact that the several measurements are not usually independent but correlated one with another. There are mathematical techniques for dealing with the situation and I have endeavoured to outline the simpler of them elsewhere (Tanner, 1952). Let me just mention one. This is the technique of the discriminate function, and let me as an illustration of the method tell you a new way of finding out whether a given person is a man or a woman.

If you are in serious doubt about this matter you may begin your investigation by measuring the bi-acromial and bi-iliac dimensions. Then, consulting *Fig.* 8, plot the shoulder and hip width one against the other in the appropriate place. In this chart the solid circles are males and the open ones females, and you will see that though there is a certain amount of overlap (as in real life), in general the line marked "overall" separates out males into the upper left-hand area and females into the lower right-hand area. The significance of the lines marked 1 per cent and 5 per cent is that if your unknown lies south-east of that 5 per cent line it has a less than 5 per cent chance of being male, and if it lies below the 1 per cent line the chances of it being male are very small.

Now this discriminate function technique can be extended to take in more than two measurements, though of course it is not possible to plot the results simply as in this chart. But one constructs an equation with as many measurements in it as one likes, and

if a patient's score is above a certain figure, then he belongs to one class, and if it is below he belongs to the other. The applications of this technique are fairly obvious.

One could, for example, given a longitudinal series of measurements in normals and in cases of Angle Class II, go back to some early age where differences between the two groups were not obvious and construct the discriminate function which would in fact best separate the two groups at that time. One could then calculate the score of any new patient on this function and get the best possible idea as to whether he would turn into a case of Angle Class II as the years went by. I have, in fact, myself used exactly this technique to distinguish between normal rabbits and rabbits bearing the so-called dwarf gene. Soon after birth it is not possible to tell which are the dwarfs in a given litter just by inspection, but careful measurement of the ears and some other parts, coupled with a little mathematical manipulation, gives you the correct answer a good proportion of the time.

Perhaps something of the same nature might be effected in orthodontic practice when some of these relatively newer, but by no means complicated, statistical methods should come to be applied to carefully collected longitudinal data in this field.

REFERENCES

Björk, A. (1955), *Amer. J. Orthodont.*, **41**, 198.

Holcomb, A. E., and Meredith, H. V. (1956), *Growth*, **20**, 159.

Medawar, P. B. (1945), *Essays on Growth and Form presented to D'Arcy Wentworth Thompson*, ed. W. E. Le Gros Clark and P. B. Medawar. Oxford: Clarendon Press.

Richards, O. W., and Kavanagh, A. J. (1945), *Ibid.*

Sorsby, A., Benjamin, B., Davey, J. B., Sheridan, M., and Tanner, J. M. (1957), M.R.C. Spec. Report Ser. No. 293.

Tanner, J. M. (1947), *Proc. R. Soc. Med.*, **40**, 301.

— — (1951), *Human Biol.*, **23**, 93.

— — (1952), *Arch. Dis. Childh.*, **27**, 10.

— — (1955), *Growth at Adolescence*. Oxford: Blackwell Scientific Publications.

— — (1958), in *Modern Trends in Pædiatrics*, ed. A. Holzel and P. Tizard. London: Butterworth.

— — Healy, M. J. R., Lockhart, R., MacKenzie, J. D., and Whitehouse, R. H. (1956), *Arch. Dis. Childh.*, **31**, 372.

Thompson, D. W. (1942), *On Growth and Form*, 2nd ed. Cambridge: University Press.

DISCUSSION

Mr. J. R. E. Mills, in thanking Dr. Tanner for his paper, said that it would have interested the Founder of the Society very much. Those junior members of the Society who, like himself, had not the privilege of knowing Dr. Northcroft, remembered him best in connexion with the Dental Board Lectures in 1924. In the lecture which he gave in that series Dr. Northcroft had employed precisely the type of prediction curve mentioned by Dr. Tanner.

During the time that he was an active member of the Society he had done much to stimulate interest in normal growth and development and it seemed a pity that latterly such studies had been almost confined to America.

Cephalometric investigations of normal growth could be divided into three stages. The early ones were comparatively inaccurate and their findings were that the average human head maintained its shape and proportions throughout growth. In the second phase some exceptions to that were found; it was realized that the face and especially the mandible became more prognathous. In the third phase the importance was realized of longitudinal studies. The average trends were not applicable to individual cases and there was a wide range of variation. Mr. Mills imagined that statistics might be used to work out future patterns with one of the distorted curves. This should also give the standard error to indicate the probability of a given individual following this pattern.

He was afraid that he was not at his best with mathematics and this made him a little doubtful about using statistics, but he wondered whether one could be sure that an extreme case was going to react to the formula as well as an average case.

Perhaps he might illustrate that by Dr. Tanner's ballet dancers. There was a formula by which one could tell from the height of a girl of 12 years what would be her probable height when she was fully grown. But could it be said that a girl who was abnormally small at 12 years would necessarily remain abnormally small? Might it not be that a proportion of these girls were merely late in growing and would, in fact, grow more than the average and thus upset the formula?

Dr. Tanner's techniques might have application in the development of the dentition. We had in Miss Clinch's collection, the finest series of serial models in the world. One of the findings from a study of these was that there was an increase in intercanine width about the time that the permanent incisors erupt. Where the deciduous incisors were not spaced there tended to be more increase than in those cases where they had been spaced. He wondered if it would be possible to produce diagrams which would show the probability of a given child ultimately having sufficient room for the permanent incisors, from a measurement of the intercanine width at, say, the age of 8. This would have clinical application but he wondered whether it would be applicable to an extreme case.

Hellman in his growth studies found that chronological age was not reliable and used his own method for assessing developmental age. Did Dr. Tanner find chronological age satisfactory or was there any alternative?

Dr. Tanner, in reply, said that the question whether the prediction applied equally well to the people at the periphery of the distribution as to those at its centre was a fairly straightforward mathematical problem. If the distribution was a normal Gaussian one, and if the regression of the thing predicted in the initial measurement was also normal in form, then the predictions would apply equally well to all persons within the distribution. If, however, the distribution was not normal, but skewed, such as it was, for example, for body-weight, then either the method of prediction had to be rather different from that which he had described, or else, perhaps more satisfactorily, a transformation had to be made to the variate to make it into one that was normally distributed. For example, the transformation log (weight in lb., 25) approximately normalizes the distribution of weight for young men.

If, on the other hand, one was endeavouring to predict what was going to occur for an abnormal person, for example a polio patient, who lay outside the normal population, then further difficulties certainly did arise. Suppose, for example, a child had an old polio in the left leg and one was going to take a piece out from the right leg to balance the shortening of the left: the question was how much one should take out. From studying normals one knew how much the right leg would grow in the normal case, but the difficulty was that in the polio case the right leg was no longer normal, because due to the lesion in the left leg it was being used in a somewhat different fashion from usual.

Mr. Mills, however, was probably referring to the meaning of "abnormal" in which one designated the people at the end of the ordinary distribution as this, rather than referring to people with some definite pathological lesion. These two different senses of "abnormal" must be kept clearly distinguished.

He agreed entirely with Mr. Mills that chronological age was in many circumstances not a good guide at all, and indeed he made a practice of telling his students that to say a boy was 14 years old was almost meaningless in relation to growth and development; one must specify whether he was pre-pubescent, pubescent, or post-pubescent, for his real developmental age might be anywhere from 11 to 18.

Developmental age could be measured in various ways, the two most commonly used being bone-age and tooth-age. For bone-age one usually assessed the degree of ossification of the wrist, a procedure which started by taking a posterior-anterior X-ray of the left hand. For example, in predicting the final height of a person an adjustment had to be made for the developmental age; a person who was developmentally advanced at age, say, 13, and 5 ft. 6 in., would perhaps end up at 5 ft. 8 in., whereas a person who was developmentally retarded at 13 and 5 ft. 6 in. might well end up at 6 ft. 0 in. The adjustment for skeletal age was not so necessary before puberty, but absolutely necessary during it.

Tooth-age and bone-age appeared to be not very closely related. There were, for example, some diseases in which one was very advanced and the other normal. One of these was adrenal hyperplasia, in which the excessive secretion of adrenal hormones caused very advanced ossification to occur in the bones of the wrist, but had little effect on tooth eruption. Hypothyroidism, on the other hand, caused a retardation both in bone- and in tooth-age. The amount of published information on the precise relations between bone-age and tooth-age was exceedingly small and data bearing on this were particularly needed.

Mr. J. H. Hovell said Dr. Tanner had put his finger right on the spot in assuming, and almost taking for his theme, that orthodontists were dealing with variations of the normal. He did not know what percentage of cases came into this category, but he should say it was extremely high. Certainly treatable cases are almost entirely variants of the normal skeletal pattern and of the morphology and function of the soft tissues.

He had recently coined a new term as a result of the finals examination papers he had recently marked. Much reference had been made in candidates' answers to open bite, rickets, cleidocranial dysostosis, achondroplasis, syphilis, endocrine disorder, and so on.

"Pathodontists" is the term and such conditions should all be abolished from orthodontic literature and thinking. He felt sure Dr. Tanner was thinking along these lines. He had given a useful lead and possibly he could further investigate these variations.

Miss L. M. Clinch thanked Dr. Tanner for making statistics intelligible to her, to some extent, for the first time.

She was in the position, she said, of having a good number of serial models between the ages of 4 and 14, taken every year, and quite honestly she did not know what to do with them. She wished Dr. Tanner would tell her.

Dr. Tanner, in reply, said he was not sure whether this was a question or a request!

Having been himself engaged in longitudinal work in the last ten years he had come to the not very startling conclusion that it was essential before starting a longitudinal study to know exactly what one was going to do with it and exactly the questions that one hoped its data would answer. Unless some hypothesis was formulated and kept in mind, material tended to be accumulated and never analysed. This was one of the great difficulties of longitudinal studies, because questions in this field were not very easy to frame. Nevertheless, it was essential that the point of view of the ordinary scientist, that is, that he was testing a certain defined hypothesis with the data to hand, must always be kept in the forefront of the research worker's mind.

Mr. P. H. Burke said he would like to ask Dr. Tanner what were his views on a slightly different approach to the problem of forecasting growth. It has been said that orthodontic treatment proceeded more satisfactorily when the rate of growth was more rapid. Was it possible to use any of the other changes which were occurring in adolescent growth as a prognosticator of the growth which would occur in the face? He believed leg length was the first dimension which increased in the adolescent. Could one use that to help assess facial growth?

Dr. Tanner replied that one certainly could use changes other than those in stature, but he did not think that leg length was at all a suitable one. The reason for this was that the adolescent growth spurt in leg length was very small, and in practice it might be difficult to discover when it was occurring.

The simplest way to discover the time at which growth was about to proceed most rapidly was to follow the development of the secondary sex characters. The first thing to occur in the girl at adolescence was the appearance of the breast-bud. The maximum velocity of growth

in height. and probably of growth in faeial dimensions, oeeurred a little time after this, and thus one eould be forewarned so as to start treatment at approximately the right time. The same thing would be aehieved by following bone-age with X rays of the wrist, but at this partieular time it was really simpler to rely on the seeondary sex eharaeters.

Mr. D. F. Glass asked Dr. Tanner to say more about the growth of the tobaceo leaf whieh he deseribed. Did he consider that this type of growth eould be applied to a flat membrane bone like the sides of the maxilla or the vault of the skull? Dr. Tanner had earefully avoided the term "growth eentre" and spoke of growth gradient. Did he think this would apply to bone growth?

Dr. Tanner, in reply, said he preferred the term "growth gradient" to "growth eentre" because as a rule one only had information on the differential rates of growth at different plaees for mathematieal analysis, and the mathematieal analysis might lead to the eentral point of the gradient being a "virtual" one. That is, one not existing in reality, but plaeed outside the body.

He eould not answer the question as to whether there was a growth eentre in the maxilla; he thought the best approaeh would be to analyse, in the ways he had indicated, a series of longitudinal lateral skull X rays. He thought that sueh an analysis might well show up the growth gradients better than the split line techniques. He had hopes that some orthodontist interested in these problems would eventually take on a projeet of this kind, but he did not know of anybody working on these lines at present.

The President thanked Dr. Tanner for his most interesting paper and for the little aneedotes whieh enhaneed the pleasure of his listeners. The subjeet was one whieh some of them had previously found diffieult and perhaps uninteresting. (*Applause.*)

REPORTS OF MEETINGS

ORDINARY MEETING, January 14

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, January 14, 1957, at 7.30 p.m. The President, Professor C. F. Ballard, occupied the Chair.

The Minutes of the Annual General Meeting, held on December 10, 1956, were read, confirmed, and signed.

Two new members, Mr. Sandiford and Mr. Howard, were introduced to the President and admitted to full membership.

The President welcomed the visitors and invited them to participate in the discussion following the paper.

The President then delivered the Presidential Address:—

"*The Aetiology of Malocclusion—an Assessment*"

ORDINARY MEETING, February 11

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, February 11, 1957, at 7.30 p.m. The President, Professor C. F. Ballard, occupied the Chair.

The Minutes of the Ordinary Meeting held on January 14, 1957, were read, confirmed, and signed.

Two new members, Mr. Hardy and Mr. Martin, were introduced to the President and admitted to full membership.

The following candidates for membership were elected on a show of hands:—

Mr. Frederick Allan, B.D.S., L.D.S. (Eng.), 16, Lewes Crescent, Brighton, Sussex.

Mr. P. J. Blyth, L.D.S. (Bristol), L.D.S. R.C.S. (Eng.), D.Orth. R.C.S. (Eng.), 10, Lansdown Place, Clifton, Bristol.

The President welcomed the visitors, particularly mentioning Dr. Stanley J. Rogge, of the U.S.A., and invited them to participate in the discussion following the presentation of the paper, as though they were members.

The following paper was presented by Mr. J. R. Halden:—

"*Report on the Edgewise Appliance*"

ORDINARY MEETING, March 11

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, March 11, 1957, at 7.30 p.m. The President, Professor C. F. Ballard, occupied the Chair.

The Minutes of the Ordinary Meeting held on February 11, 1957, were read, confirmed, and signed.

Two members, Mr. P. J. Blyth and Mr. F. Allan, who were attending for the first time, were introduced to the President and signed the Obligation Book.

Eight candidates for election were admitted *en bloc* by a show of hands:—

Mr. C. P. Briggs, B.D.S. (Lond.), L.D.S. R.C.S. (Eng.), The Charles Clifford Dental Hospital, Wellesley Road, Sheffield 10.

Mr. F. McGonigal, L.D.S., R.F.P.S. (Glas.), D.D.O., R.F.P.S. (Glas.), "Willow Lawn", Hempsted, Gloucester.

Mr. J. P. Hughes, L.D.S. (V.U. Manchester), "Merton House", 585, Manchester Road, Denton, Lancs.

Mr. W. O. Mulligan, D.D.S., 15, Charlotte Street, Saint John, New Brunswick, Canada.

Mr. M. F. Scott, L.D.S. R.C.S. (Eng.), 41, Birchwood Avenue, Sidcup, Kent.

Mr. V. P. Webb, B.D.Sc. (Queensland), D.D.S., D.Orth. (Toronto), A.M.P. Building, Edward Street, Brisbane, Queensland, Australia.

Mr. S. H. Werner, Sturegatan 36, Stockholm O.

Mr. T. H. M. Wynne, B.D.S. (U. Liverpool), Orthodontic Department, Birmingham Dental Hospital, 53, Barwick Street, Birmingham 3.

The President then welcomed any visitors who were present and invited them to take part in the discussion following the paper.

Introducing the author of the paper, the President said Dr. O'Meyer would be well known to many members; he was a surgeon dentist by qualification in France and also a Master of Science from the University of Illinois. In addition, Dr. O'Meyer was Head of the Orthodontic Department of the École

Odontologique in Paris, a member of the E.O.S., and, as one or two members knew to their cost, he was Treasurer of the French Orthodontics Society.

Dr. R. O'Meyer then delivered the following paper:—

"*A Study of the Growth in Height of the Alveolar Process: O'Meyer's Sign*"

DEMONSTRATION MEETING, May 13

A Demonstration Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, May 13, at 7.30 p.m.

The President was in the Chair and 112 members were present.

The Minutes of the March meeting were read, confirmed, and signed.

Mr. C. P. Briggs, Mr. L. M. Irwin, and Mr. T. H. M. Wynne were introduced to the President and admitted to full membership of the Society.

The following candidates for membership were elected unanimously by show of hands:—

Mr. A. Black, L.D.S. R.C.S. (Eng.), Moor House, Hawkhurst, Kent.

Mr. J. F. Crawford, L.D.S., The Turner Dental Hospital, Bridgeford Street, Manchester 15.

Mr. A. Nesbitt, L.D.S., D.Orth. R.C.S., 257, Green Lane, Norbury, London, S.W.16.

The President then introduced the demonstrators and proposed a vote of thanks to them in advance.

The date of the next meeting on October 14, 1957, at 7.30 p.m., was announced by the President.

At 8.30 p.m. there was a break for refreshments, and at 9.30 p.m. the meeting closed.

ORDINARY MEETING, October 14

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, October 14, 1957, at 7.30 p.m. The President, Professor C. F. Ballard, occupied the Chair.

The Minutes of the previous Ordinary Meeting were read, confirmed, and signed.

Two members, Mr. A. Nesbitt and Mr. J. F. Crawford, whose election to full membership had been confirmed at a previous meeting, were introduced to the President.

Four candidates were admitted by show of hands, *en bloc*:—

Mr. J. A. Bell, B.D.S., 29, Radley House, Gloucester Place, N.W.1.

Mr. R. S. Bell, L.D.S. R.C.S., D.Orth.R.C.S., 6, Netherton Road, St. Margaret's, Twickenham, Middlesex.

Mr. G. A. James, B.D.S., Royal Dental Hospital, Leicester Square, London, W.C.2.

Miss June P. Murray, B.D.S., L.D.S., 47, Ightenhill Park Lane, Burnley, Lancs.

The President said it had been necessary to change the programme considerably. Because of the absence of the Author for November on research in the United States, the December meeting would be postponed to December 16. Mr. M. A. Kettle would give his paper in November instead of December, and the paper scheduled for November would be given in December.

In addition, Dr. Bransby was not prepared to give his lecture to the present meeting. At the last minute a programme had been composed of three short communications, and the Society were indebted to the authors—Mr. R. T. Broadway, Miss D. R. Ridley, and Mr. H. L. Leech—for having provided them. Some would feel, in any event, that they were more interesting than a lecture on statistics, which it had been proposed that Dr. Bransby would give.

Mr. R. T. Broadway, Miss D. R. Ridley, and Mr. H. L. Leech made the following communications, respectively:—

"*Depression of Lower Incisors*"

"*The Use of Contoured Canine Orthodontic Bands*"

"*The Treatment of Angle's Class II, division* 1 *and Class II, division* 2 *in Identical Twins*"

ORDINARY MEETING, November 11

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, November 11, 1957, at 7.30 p.m. The President, Professor C. F. Ballard, occupied the Chair.

The President announced, with regret, the death of Mr. Bertram Samuel. As far as he

had been able to trace in the short time available to him that afternoon, Mr. Samuel was a member of the Society as early as 1913, and it was likely that he had been a member earlier than that. Mr. Samuel had been Auditor from 1916 to 1920, Honorary Librarian from 1924 to 1928, Vice-President from 1929 to 1933, and President in 1934.

Members stood in silence in tribute to Mr. Samuel.

The Minutes of the previous Ordinary Meeting, held on October 14, 1957, were read, confirmed, and signed.

The following members, who were attending for the first time since their election was confirmed, were introduced to the PRESIDENT: Miss J. P. Murray, Mr. J. A. Bell, Mr. G. A. James, and Mr. R. S. Bell.

The following candidate was admitted by show of hands:—

Mr. R. T. Broadway, M.D.S., F.D.S., D.Orth. R.C.S., 20, Chester Road, Chigwell, Essex.

The PRESIDENT welcomed visitors and expressed the hope that they would feel at liberty to take part in the discussion as they wished. He called on Mr. M. A. Kettle to present his paper, entitled:—

"*Treatment of the Unerupted Maxillary Canine*"

ANNUAL GENERAL MEETING, December 16

THE ANNUAL GENERAL MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, December 16, at 7 p.m. It was followed by the Eleventh Northcroft Memorial Lecture. The retiring President, Professor C. F. Ballard, occupied the Chair for the first part of the proceedings, and the incoming President, Mr. J. W. Softley, after his induction.

Minutes.—The Minutes of the Ordinary Meeting held on Monday, November 11, 1957, were read, confirmed, and signed.

Election of Officers and Councillors.—The PRESIDENT said that there were no other nominations and he had therefore to announce that the Officers and Councillors for 1958 nominated by the Council, as printed on the agenda paper, were duly elected.

Election of Two Auditors.—On the motion of Mr. P. H. Burke, seconded by Mr. D. F. Glass, the present Auditors were re-elected.

Report of the Treasurer.—The TREASURER (Mr. J. S. BERESFORD) presented his report, as follows:—

There have been some changes this year in the Society's investments. Our holding of 500 National Savings Certificates (7th Issue) was sold for £512 10s.; £450 has been invested in 600 National Savings Certificates (10th Issue); £500 has been invested in Corporation of London $5\frac{1}{4}$ per cent Stock 1976/79; and £600 in Hertfordshire $5\frac{1}{4}$ per cent Stock 1965. The purchase price in each case is shown in the Balance Sheet. The amount of material which the Society publishes is increasing greatly. Although this is a valuable contribution to Dental Science, it is so expensive that our entire income is absorbed. I consider it is now time to think of an increase in the price of the *Transactions* and an increase in the subscription for Corresponding Members.

On the motion of the TREASURER, seconded by Miss L. M. CLINCH, the report was received.

Mr. HAROLD CHAPMAN said that the excess of expenditure over income was disappointing. Some consideration might, he thought, be given to the cost of the *Transactions* which loomed so largely in the accounts. It was the largest single item.

It was not easy to arrive at what the *Transactions* actually cost, but he had written to Mr. Beresford and had asked for an explanation of two points. He believed members would be interested because they were important items and it might be necessary to increase subscriptions to meet the deficiency.

It was accepted that 200 members would subscribe to the *Dental Practitioner*. If there were not 200, the Society had to make up the amount, so the deficiency was an item of a special character, but still it was an expense. Again, the Society were limited to not more than eight pages in the *Dental Practitioner*, and as the *Transactions* occupied more space than that, the extra pages had to be paid for. The extra cost for the three months May, June, and July, 1957, was £141 9s., including

£15 for blocks, so that was another considerable item in the expenditure.

As this referred only to three months, the item might well be considerably more when the whole account was made up.

Then there was the cost of postage and packing, which in one year amounted to about £25, another item of considerable importance.

In 1955 the *Transactions* cost £500 for probably 450 copies. He could not be sure about the number, but the gist of it was that the cost per copy of the *Transactions* for the year 1955, and probably for all years, was several shillings over £1. He did not know whether that could be made up by increasing the charge for the *Transactions* which he thought Mr. Beresford had mentioned in his report. At present, the charge per copy to non-members, he believed, was £1 10s., and the Council might well consider increasing it. It might be a good plan if the accountants could be asked to work out what the *Transactions* actually cost. As he had already mentioned, there were several items that were hard to work out, but no doubt it could be done satisfactorily.

In the meantime, they must hope to avoid an increase in subscriptions by a further charge for non-members' copies, and they must also hope that inflation had now ceased and that the cost would not continue to rise.

The PRESIDENT thanked Mr. CHAPMAN for his consideration of the accounts. Some members might know, he said, that he had always given considerable thought to the Society's finances and had also given them very important advice.

There was so much money at the back of them at present in investments that as long as they could afford to run the Society using all their yearly income they were justified in not budgeting, as it were, for a surplus each year. He did not know whether the TREASURER would agree about that, but he thought they could perhaps afford to spend all their income each year. Would Mr. Chapman care to comment on that?

Mr. CHAPMAN said he liked to see a surplus rather than the other way round. It seemed only two or three years to him since they were two or three hundred pounds down in a very short time before the subscriptions were raised. One would like to avoid that if possible, and of course it was most desirable to avoid raising the subscription if that was possible.

He would speak privately to Mr. Beresford about the other matter.

A motion by the PRESIDENT from the Chair that the report be adopted was carried.

Report of the Secretary.—The SECRETARY (Mr. H. L. LEECH) presented his report, as follows:—

During the last year from December, 1956, to November, 1957, seven meetings of the Society have been held, with an average attendance of 97 members and visitors per meeting, which is a slight increase on the previous two years. During the year 20 new members have been elected. There have been 7 resignations and 1 death, and the membership, as at December 31, 1957, is expected to be 462.

There has been no Country Meeting this year, but the Council has decided to celebrate the Jubilee of the Society in 1958 by holding a two-day meeting in London, May 9 and 10.

On the motion of Mr. H. L. LEECH, seconded by Miss L. M. CLINCH, the report was received.

On the motion of Mr. H. L. LEECH, seconded by Mr. HOWELL RICHARDS, the report was adopted.

Report of the Librarian.—The Librarian (Mr. A. G. TAYLOR) presented his report, as follows:—

First I must mention the gifts the Library has received from its members. From Mr. HAROLD CHAPMAN and Mr. H. E. WILSON, reprints of papers by Koski and Virolainen and by Roger Villain, and copies of *Annales* and *Cahiers Odonto-Stomatologiques*, as well as other material. From Mr. J. F. PILBEAM and from Mr. F. BOCQUET-BULL, copies of past *Transactions* of this Society and of the European Orthodontic Society.

This brings me naturally to the trade in *Transactions* which helps the Society's finances. I am always eager to accept copies of past *Transactions* from members, and in particular,

the years which, like the great claret vintages, include the figure four, as many of these are out of print.

More members have borrowed more books this year than last year, but 1955 still holds the record. The one respect in which this year has been notable has been in contact with Russia, China, Poland, and Roumania, and we now exchange publications with Roumania, which has shown the greatest enthusiasm.

On the motion of Mr. A. G. TAYLOR, seconded by Mr. HAROLD CHAPMAN, the report was received.

On the motion of Mr. A. G. TAYLOR, seconded by Mr. R. E. RIX, the report was adopted.

Report of the Editor.—The Editor (Mr. W. J. TULLEY) presented his report, as follows:—

I have to report that the *Transactions* for 1956 are now in the page proof stage. I had hoped they would be ready for distribution before Christmas, but there have been many setbacks and they should be ready in January.

As you remember, we had a Country Meeting in Newcastle in 1956 which has almost doubled the amount of material in the *Transactions* for that year, and secondly, authors have been very late in submitting papers and we have had to go to press without a few small contributions. It was most unfortunate that of the number of demonstrations given at Newcastle, only three have been received for publication.

I have better news concerning the *Transactions* for this year. All the papers are up to date, and when I receive the outstanding accounts of demonstrations we will be able to go ahead with the printing and they should be ready by the end of March at the latest.

One of the big problems has been to get our material published in the *Dental Practitioner* when we have had a large number of papers at a Country Meeting. We have, over the past year, been subsidizing extra pages above the eight pages originally agreed with the *Practitioner*. The Council have been discussing the possibility of an Orthodontic Journal published quarterly. It was felt that this would be most valuable as it could include correspondence and papers from overseas.

However, the cost of such a journal is beyond our means. We have agreed, however, to subsidize extra pages in the *Practitioner* so that we can have a 20-page supplement in each issue. These supplements will contain a full record of our proceedings and will be "run on", to use the printer's expression, and the twelve supplements for the year bound as the *Transactions*.

The exact way in which this will be done is still under discussion, but it is hoped to start it early in the New Year as soon as all the outstanding material for 1957 has been published.

We still continue to enjoy a very happy liaison with Messrs. John Wright & Sons of Bristol. They are most co-operative, and I am sure that this new scheme will be a considerable improvement and enable us to get our material published quickly.

On the motion of Mr. W. J. TULLEY, seconded by Mr. J. R. E. MILLS, the report was received.

On the motion of Mr. W. J. TULLEY, seconded by Mr. H. E. WILSON, the report was adopted.

Report of the Curator.—The Curator (Miss L. M. CLINCH) presented her report, as follows:—

The Museum is still housed next door in the Institute of Public Health, 28, Portland Place, where it can be seen on weekdays between 10 a.m. and 5 p.m.

During the year Mr. FINCH presented models of bilateral transposition of the maxillary canines and first premolars; Mr. FENTON presented photographic copies of serial radiographs showing the history of a buried deciduous molar; and Dr. SPITZER presented models and radiographs of a case of mongolism.

I would be grateful if any members could help me by presenting old types of appliances, fixed or removable, as I am trying to make a collection of the various types which have been and are being used—precious metal, vulcanite, steel, etc. There is already in the Museum an ivory plate carrying a peg for tooth movement and a collection from that period onwards would be of interest.

On the motion of Miss CLINCH, seconded by Mr. HAROLD CHAPMAN, the report was received.

On the motion of Miss L. M. CLINCH, seconded by Mr. J. W. SOFTLEY, the report was adopted.

Member attending for the First Time since his Election.—Mr. R. T. BROADWAY, who was attending for the first time since his election had been confirmed at a previous meeting, was introduced to the President and signed the Obligation Book.

The PRESIDENT announced that that concluded the business of the Annual General Meeting.

Guests and visitors were then admitted.

Eleventh Northcroft Memorial Lecture.—The PRESIDENT welcomed any visitors who might be present and asked them to take part in the discussion, if they wished to do so.

In calling upon Dr. J. M. Tanner to present the Northcroft Memorial Lecture, he said that this was the Eleventh Northcroft Memorial Lecture but the date had had to be changed from November, which was the usual date, because after agreeing to give the paper Dr. Tanner had had to go to America to carry out some research work.

Everyone was aware that Dr. Northcroft was the founder of the Society. Mr. Chapman and Mr. Badcock were inaugural members, but it was the inspiration of Dr. Northcroft that produced the Society.

Dr. Tanner was Lecturer in the Institute of Child Health in the University of London. He was recognized as a world authority on child development, and the only proof required of this was that he was a member of the World Health Organization Study Group on the Psycho-Biological Development of the Child, which met for four consecutive years from 1953. He was also the co-author with Dr. Inhelder of the *Proceedings* of that Study Group. Two years' *Proceedings* had been produced so far, and they made very interesting reading. Dr. Tanner was the author of many articles on child development published both here and in America and of a book called *Growth at Adolescence*. As many of the audience would know, he was the head of a team of workers studying child development and in that research team there was a member of the B.S.S.O., Mr. Walther, so Dr. Tanner was well aware of the problems of orthodontists.

He had much pleasure in calling upon Dr. Tanner to read his paper.

Dr. J. M. TANNER, M.D., Ph.D., D.P.M., Lecturer in the Institute of Child Health, University of London, delivered the following paper:—

"*Growth and the Prediction of Abnormality*".

VALEDICTORY ADDRESS

LADIES AND GENTLEMEN.

Now that my year of office has come to an end I express personal pleasure with regard to two developments in the Society which I (personally) thought were necessary. They will enable a greater number of members to take an active part in our proceedings, both as far as attendances at meetings are concerned and for bringing material before the Society. The first development is the insertion into our programme of a country meeting and the second, which is necessitated by the first, is the arrangements that we have come to with Messrs. John Wright & Sons of Bristol to have an Orthodontic Supplement to the *Dental Practitioner*. I hope our younger members will take full advantage of these developments to bring short communications before the Society, and papers of course if they wish to do so.

In this connexion I wish to stress that the writing up and the presenting of short communications is very stimulating exercise and a preliminary to the writing of papers and longer scientific communications. However, I would warn the writers of short communications against two of the failings of much orthodontic material that is produced. The first is inadequate use of the diagnostic methods that are available to us today. For instance, it is to my mind useless presenting before and after models only in a discussion of treatment. Any discussion of treatment must be accompanied by cephalometric analysis of the case before treatment, at the end of active treatment, and after all retainers have been out for at least a year, and likewise accurately

orientated full face and profile photographs. This brings me to my second point. All through orthodontic literature there has been confusion of cause and effect. This is in my view due to failure to study a sufficient number of individuals longitudinally. We have been prone to jump to conclusions from cross-sectional study, or even from brief acquaintance with one clinical case. This is no doubt in part due to lack of knowledge of the basic facts of evolution and its significance to the development of the individual—a failing of undergraduates. Only by teaching longitudinal study of treated and untreated cases, with due regard to biological principles, have we resolved some of the problems of ten or more years ago, and can we resolve many of the problems that still remain.

In conclusion I must thank most sincerely the officers who have made my year of office a pleasant and happy one. I would remind you that these officers give a considerable amount of their spare time to the running of the Society for your benefit.

It is now my pleasant duty to call Mr. Softley to the platform to take over the chain of office.

Mr. Glass, who moved a vote of thanks to the retiring President, said the Society had had a very successful year and all members were greatly indebted to the retiring President for all the work he had done during his year of office. Professor Ballard was undoubtedly one of our leading orthodontists and the Society was grateful to him for the year's energetic programme.

Professor Ballard had been very dogmatic in many of his statements; however, clinical experience had proved him to be correct in most of these.

He was a good mixer and broad minded enough to listen to the other point of view and his status in British Orthodontics had been recognized by London University which had appointed him Professor in Orthodontics.

Mr. Glass called upon the members to show their appreciation to the retiring President in the customary manner.

The President thanked Mr. Glass for what he had said. He must admit that he made dogmatic statements at times. He had been stimulated to do so by the colleagues with whom he discussed the problems of orthodontists. One of the great values of being attached to a school in London was that one was not permitted to stagnate. If he had managed to contribute anything to orthodontics, it was to a great extent due to the colleagues he had had round him. Anything he managed to contribute as he got into old age would again be due to the stimulation of the colleagues with him at the Eastman and at other London Schools.

Induction of New President.—The President inducted Mr. J. W. Softley as the new President and handed over to him the chain of office.

Mr. J. W. Softley then took the Chair. He thanked the Society for the honour they had done to him in electing him President and declared the meeting closed.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and

Income and Expenditure Account

FOR THE YEAR ENDED SEPTEMBER 30, 1957

FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS
22 Queen Street, London E.C.4

The British Society for the Study of Orthodontics

INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1957

1956									1956								
£	s.	d.		£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
10	10	0	To Museum Rent				10	10	0				By *Members' Subscriptions:*—						
95	4	4	,, Printing and Stationery ..	127	10	2							1957 Subscriptions	1,260	11	10			
361	12	6	,, Reserve for Cost of *Transactions*	850	7	0							Adjustment in respect of Past Years	58	4	3			
75	0	0	,, Reserve for *Practitioner* Short Fall Account	75	0	0				1,264	6	11					1,318	16	1
–	–	–	,, Reserve for *Practitioner* Extra Cost of Printing	141	9	0				131	3	2	,, Sale of *Transactions*				70	6	7
							1,194	6	2	12	10	0	,, Interest on Savings Certificates				25	0	0
55	5	10	,, Country Meeting				–	–	–	17	5	4	,, Interest on 2½% Consolidated Stock				17	5	4
36	17	3	,, Postage				34	17	11				,, Interest on 4% Consolidated						
5	0	0	,, Lantern and Film Expenses ..				14	11	0	20	0	0	Stock				20	0	0
46	13	0	,, Hire of Hall				54	0	0	17	10	0	,, Interest on 3½% Defence Bonds				17	10	0
31	5	3	,, Reporting				39	12	6				,, Interest on 5¼% Hertfordshire						
52	1	0	,, Refreshments				76	9	0	–	–	–	County Council Stock ..				5	14	5
8	8	0	,, Audit and Accountancy ..				8	8	0				,, Interest on 5¼% Corporation of						
3	19	6	,, Insurance				3	8	6	–	–	–	London Stock				3	11	11
5	15	9	,, Library and Journals				4	19	6				,, Interest on Post Office Savings						
26	5	0	,, Northcroft Memorial Lecture ..				26	5	0	22	12	10	Bank Account				21	11	0
23	2	0	,, Honoraria				23	2	0				,, *Excess of Expenditure over*						
7	5	5	,, Sundry Expenses				7	15	8	–	–	–	*Income for the Year*				32	13	11
34	4	0	,, Depreciation on Furniture and Equipment				34	4	0										
606	19	5	,, *Excess of Income over Expenditure for the year*				–	–	–										
£1,485	8	3					£1,532	9	3	£1,485	8	3					£1,532	9	3

The British Society for the Study of Orthodontics

BALANCE SHEET as at 30th September, 1957

1956								
£	s.	d.		£	s.	d.	£	s. d.
			Accumulated Fund:—					
			Balance at 1st October, 1956 ..	3,380	18	11		
			Less Excess of Income over Expenditure for the year	32	13	11		
3,380	18	11					3,348	5 0
			Creditors:—					
			Transactions 1956 and 1957 (estimated by the Honorary Treasurer)	1,200	0	0		
850	0	0	*Dental Practitioner* Short Fall Account	150	0	0		
75	0	0	*Dental Practitioner* Extra Cost of Printing	141	9	0		
–	–	–	Northcroft Memorial Lecture ..	26	5	0		
26	5	0	Hire of Hall	27	0	0		
13	10	0	Museum Rent	7	17	6		
7	17	6	Printing and Stationery	25	5	0		
4	16	0	Postage	3	13	1		
3	11	6	Audit and Accountancy	8	8	0		
–	–	–	Subscriptions in Advance ..	7	17	6		
8	19	10	Refreshments	13	15	4		
–	–	–	Country Meeting	–	–	–		
39	7	8					1,611	10 5
£4,410	6	5					£4,959	15 5

S. B. NEWTON } *Hon. Auditors*
T. L. WINN }
J. S. BERESFORD, *Hon. Treasurer*

1956								
£	s.	d.		£	s.	d.	£	s. d.
			Furniture and Equipment:—					
			Balance at 1st October, 1956 ..	371	1	0		
371	0	0	*Less* Depreciation at 5% per annum	34	4	0		
							336	17 0
			Investments:—					
487	10	0	600 National Savings Certificates, Tenth Issue at Cost	450	0	0		
575	14	0	£691 5s. 10d. 2½% Consolidated Stock at Cost	575	14	0		
485	6	3	£500 0s. 0d. 4% Consolidated Stock at Cost	485	6	3		
500	0	0	£500 0s. 0d. 2½% Defence Bonds at Cost	500	0	0		
–	–	–	£600 0s. 0d. 5¼% Hertfordshire County Council Stock at Cost	597	9	6		
–	–	–	£500 0s. 0d. 5¼% Corporation of London Stock at Cost	508	10	9		
			(Approximate Market Value £2,690)				3,117	0 6
			Cash at Bank:—					
1,121	19	1	Westminster Bank Ltd.	613	6	11		
862	1	9	Post Office Savings Bank ..	883	12	9		
							1,496	19 8
			Cash in Hand:—					
2	6	10	Honorary Treasurer	5	4	8		
4	7	6	Honorary Secretary	3	13	7		
							8	18 3
£4,410	6	5					£4,959	15 5

Certified in accordance with the Books and Vouchers of the Society.
We have verified the Investments and Cash at Bank.

FREDK. B. SMART & CO.,
Chartered Accountants,
22, Queen Street, London, E.C.4.

30*th October*, 1957.

SUBJECT INDEX

AUTHOR INDEX